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THE CALDWELL LECTURE, 1928*†

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PERMIT me first of all to express my appreciation of the honor you have conferred upon me in extending the invitation to deliver the annual Caldwell Lecture. In recalling the names of those notables who have given the preceding lectures, I felt some timidity in accepting the invitation, but when I recollected that probably those who would be in the audience this evening might in their friendship not indulge in too critical comparisons, I felt emboldened to accept. Therefore, I would simply crave your indulgence as you listen to the few words which I will have to say, and bear with my shortcomings.

The annual Caldwell Lecture is, I think, a grateful recognition of the debt which we all owe to one who was selected as an illustrious representative of the American Pioneers in Roentgenology. It has been the speaker's recent privilege to review the work of these pioneers and I can assure you that their achievements were so wonderful that laudatory remarks on the part of their biographers are quite superfluous. I know you are unanimous with me in appreciating the fact that Dr. Eugene W. Caldwell was one of the most illustrious of the early workers in the first two decades of American Roentgenology. Those who knew him personally will recall that his was a kindly, generous disposition, ready to share his honors with his confrères, and so in honoring Dr. Caldwell this evening, I feel sure that he himself, if here, would wish to share the distinction and honor of this occasion with those martyrs with whom he was contemporaneous.

In looking back over the work of the early investigators in the field of the roentgen ray, it is perhaps difficult for us to realize the obstacles which beset their paths. If we could carry ourselves back to the beginning of this century and viualize the crudeness of the tubes and coils of that period,we would have a better appreciation of the debt which we owe to Caldwell and his contemporaries. The fragile tubes and the inefficient coils with their exasperating interrupters compelled the workers in those days to concern themselves with overcoming technical difficulties, gradually preparing the way for the development of the science which has now assumed such remarkable proportions. It is, therefore, very fitting that at our annual meetings we set aside one session for an expression of our debt of gratitude.

Eugene Wilson Caldwell was the son of W. W. Caldwell and Camilla Kellogg Caldwell. He was born in Savannah, Missouri, in 1870. A few years later the family moved

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† The publication of this lecture was delayed by Dr. Hickey with the idea of expanding it into a monograph. This was never done, however, and the lecture was found among his papers. It seems appropriate to publish it in this Memorial issue.—ED.

to Concordia, Kansas. Like many of those who afterwards became distinguished for scientific work, Caldwell as a child manifested an early interest in mechanical and electrical experiments. It is related that when he was ten he constructed an induction coil to which he often referred with pride in later years. At the age of seventeen he entered the University of Kansas taking up electrical engineering. In his second year at the University he was appointed an assistant in the physical laboratory. During his student life at the University of Kansas, he became acquainted with Professor Lucien T. Blake, and when Professor Blake was called upon by the Government to conduct experiments in submarine telephony, he took young Caldwell to New York with him. Professor Blake's experiments resulted in success and the first message was transmitted between Sandy Hook Lightship and Sandy Hook. The instrument which was used at that time was known as the "Hydrophone." The work which Caldwell did under Professor Blake received due credit, and led after his graduation in 1892 to his accepting a position with the New York Telephone Company.

In looking over some of the contributions which Caldwell made to his college paper, the *University Courier*, while a student, we find the same tendency to flights of imagination which in after life gave him the power of visualizing the solution of many of the problems with which he was confronted. That the exuberance of youth was not always restrained is evidenced by the fact that the local paper in Savannah after copying an item from one of the New York papers concerning Caldwell, indulges in the following comment: "The people of Savannah will remember how he used to entertain the pupils of the high school and an electrical professor by his pranks with his plaything, the electric current."

Continuing the biographical narrative we learn that Caldwell became interested in wireless telephony and had achieved some remarkable results in an experimental way in this new field. On the announcement of the discovery of the x-ray, he began its study as an interesting electrical phenomenon. He acquired a primitive x-ray machine from a photographer who had tried to do x-ray work as an adjunct to photography and had been disillusioned.

In 1897 Caldwell rented space from a surgical instrument maker on Fifth Avenue and opened up what was probably the first x-ray office in the New York. About this time he acquired as a helper, Thomas Riker, who proved to be a most intelligent and devoted assistant. Caldwell soon felt the need of a medical training in order that he might become a true roentgenologist. He accordingly matriculated at the Bellevue Medical School where he was already teaching the subject of roentgenology. We might further add that those who are most familiar with his work at this time feel that the devotion and intelligence of Thomas Riker materially aided Caldwell in being able to carry on his laboratory while he was engaged in his professional studies at Bellevue Medical School. Next, Caldwell opened up an office on Thirty-fifth Street. This, it is related, was so filled with x-ray apparatus that in the summer he slept on the fire escape when the weather was good and on the table when the weather was bad. About 1908 the office was removed to Park Avenue where it was maintained until after his death.

About this time Caldwell felt the need of an artisan to help him manually in his developmental work of apparatus, and hired an expert model maker, Raphael Taroselli, who made up for his lack of English by his ability to understand a diagram. Raphael, as he was familiarly called, was well fitted to assist in the actual construction of apparatus as he held an engineering degree from Naples.

I think it might be interesting next to give you a brief survey of the contributions of Dr. Caldwell to electrical and roentgenologic literature.

In the *Electrical Review* for January 3, 1900, Dr. Caldwell contributes an article entitled "The Energy of Telephone Cur-

rents" in which he describes his method of measuring the current strength used in telephones. This same article was also published in *Electricity* for March, 1900. In the *Electrical Review* for May 3, 1899, Caldwell contributed a description of his modification of the Wehnelt electrolytic interrupter. This was favorably commented upon in the editorial page of the *Electrical Review* in which it appeared. This was later modified by A. A. Swinton who added a device for regulating the number of interruptions per second.

Two Italian engineers later made use of the liquid interrupter as a means of starting single phase motors, preferring the Caldwell type of interrupter (Fig. 1) to the Wehnelt type for practical work.

In the *New York Medical Journal* for July 12, 1902, Caldwell presented an original communication entitled "New Apparatus for Therapeutic Application of the X-Ray to the Larynx, Tongue, Rectum, Prostate, Cervix of the Uterus, Vagina, etc." This was a tube which, for example, may be put in the mouth in such a position that the rays may be thrown directly upon the larynx, from a target placed at the end of a tubular projection. If the positive terminal of the machine is connected to the ground wire, another tubular projection can be used as a handle and no shock will be felt by the operator or patient when the machine is in action. This tube was also made with an arrangement for cooling the target by continuous flow of cold water in a glass jacket around the target (Fig. 2).

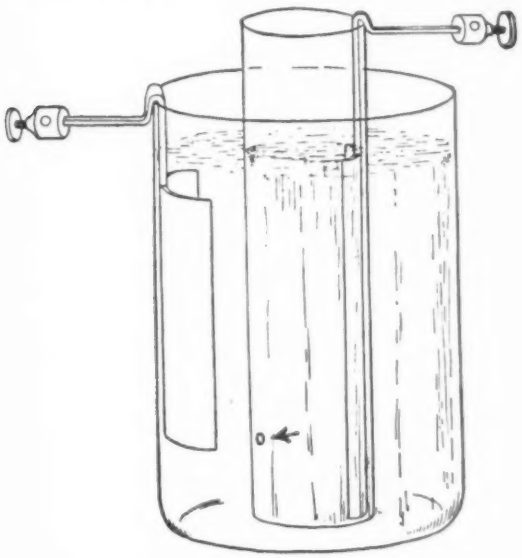

Fig. 1. Caldwell modification of the electrolytic interrupter, showing small perforation in insulating wall of inner chamber.

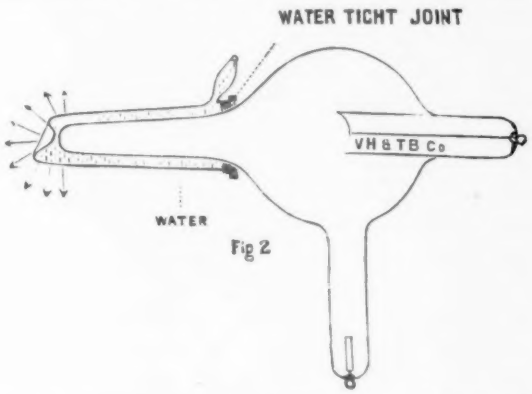

Fig. 2. Treatment tube devised in 1902 for the pharynx and similar body cavities. The tubular projection with the anode can be inserted into a body cavity, the tube being held by the operator's hand without shock as one side is grounded. One type had a water cooled jacket.

The most important contribution of Caldwell to the early literature of the roentgen ray was the volume which he produced as joint author with Dr. William Allen Pusey. This volume was published in June, 1903, and a second edition was published in June, 1904. The title of the volume was "The Practical Applications of the Roentgen Ray in Therapeutics and Diagnosis." The preface to the first edition was written by Caldwell and the preface to the second edition was written by Pusey. In Caldwell's preface he himself gives perhaps the best review of his work in the following paragraph: "There is a tendency among medical men either to under estimate the value of the X-Ray as an aid to diagnosis or to fail to appreciate its limitations. I have therefore tried to show in a conservative way just what may and what may not be accomplished with the present state of the art."

He concludes his introduction to the

book with the sentence, "To the founders of the Edward N. Gibbs X-Ray Laboratory I am indebted for rare opportunities for observation and experiments in this fascinating field."

Caldwell's part in this book was a valuable contribution because it presented a very reliable guide in technique to those who were interested in this subject. Its need and popularity are well shown by the fact that the first edition had a speedy sale and a second edition was demanded by the following year. The historical part of the first chapter is exceedingly well done in a clear and concise way. The technique recommended for the examination of various parts of the body was of a preëminently practical type and evidently written from his own experience. In it he describes the tubes which he devised for the treatment of body cavities, and his type of electrolytic interrupter which was for that period a most practical type, greatly increasing the efficiency of the induction coil.

In this volume, now of increasing historical interest, Caldwell describes the portable machine which he devised (Figs. 3*a* and 3 *b*). This portable outfit was very compact and furnished energy sufficient to permit of the roentgenographing of any part of the body. The coil employed was one designed by Caldwell himself and weighed but little over 40 pounds. It was undoubtedly one of the first portable outfits having a sufficient output to be a practical bedside instrument.

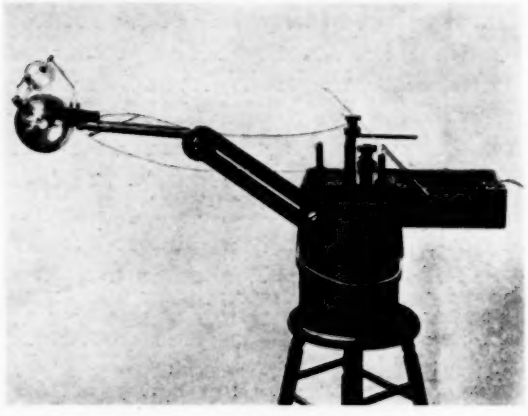

FIG. 3*a*. Caldwell portable apparatus (1904) consisting of a coil mounted in a box vertically to economize space—conventional vibrating interrupter mounted on top of box or connected in circuit with an electrolytic interrupter in a separate container. Adjustable tube stand is clamped to the box, the weight of the coil making the apparatus quite rigid. The adjustable spark gaps are in both positive and negative sides with another for measuring the resistance of the tube.

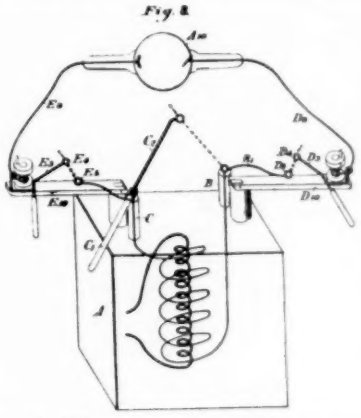

FIG. 3*b*. Diagram of portable generator.

In its practicability and efficiency it compares favorably with some of the outfits produced a quarter of a century later. Caldwell was evidently one of the first to realize that an efficient portable machine for bedside work was of great value to physicians and to the patient, and was one of the many things he did which tended in an important measure to popularize the roentgen ray. His adjustable tube stand was a model of convenience and embodied features which added greatly to the comfort of the patient.

Caldwell always believed that proper illumination of the negative was an important part of the technique in the examination. The arrangement of four roller shades on his illuminating box (Fig. 4) has been followed with modifications in many of the boxes which we are all using at the present time.

Perhaps the most momentous of Caldwell's contributions to roentgenologic literature is the paper which he presented at the Seventh Annual meeting of the American Roentgen Ray Society held at Niagara Falls in August, 1906, entitled "Skiagraphy of the Accessory Sinuses of the Nose." It

is memorable because it was really the first paper in English to call attention to the value of the roentgen ray in the study of

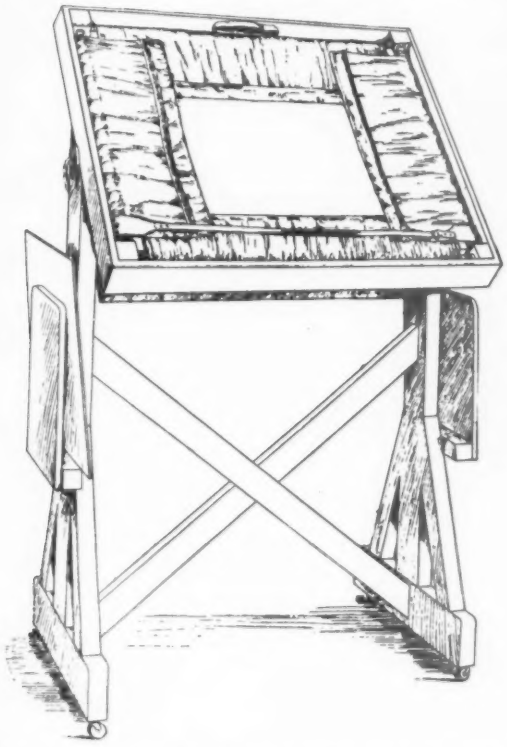

Fig. 4. Illuminating frame (1900?) with adjustable roller curtains.

the anatomy of the nasal accessory sinuses and a new way of indicating their pathology. In the opening of the paper Caldwell states that his attention was directed to this work by Dr. Coakley of New York City, who still possesses many of the original plates. A great deal of experimental work was done with anatomic material in which the sinuses were filled either with fluid or with moist gelatine which by experiment was found to offer about the same resistance to the ray as water or pus. Besides the experiments on anatomy and pathology of the sinuses, exhaustive experiments were carried on to determine the proper position for obtaining the most useful exposures. He devised an instrument for measuring the angle of the nasal with the perpendicular plane. At this time he announced that the angle of the central ray which he had found most appropriate was one of 25 degrees (Fig. 5). He called attention to the danger of producing an alopecia from too prolonged exposure and to the importance of using a proper degree of penetration to secure the most contrasting films. In this article he described the method which he devised for giving a very dense black border around the part of the plate outside of the area to be examined. It has been interesting to note how every three or four years someone rediscovers this method, renaming it and entirely ignoring the original communication of Caldwell. It is noteworthy that Caldwell gives full credit to the Germans for having started this work prior to the time in which he became interested.

In the *Boston Medical and Surgical Journal* of January, 1908, we find "The Roentgen Ray Diagnosis of Urinary Calculi" by Caldwell with the following summary:

1. The Roentgen Ray furnishes the most accurate single means we have for the diagnosis of urinary calculi.
2. It has the advantage over other methods that it not only indicates the presence or

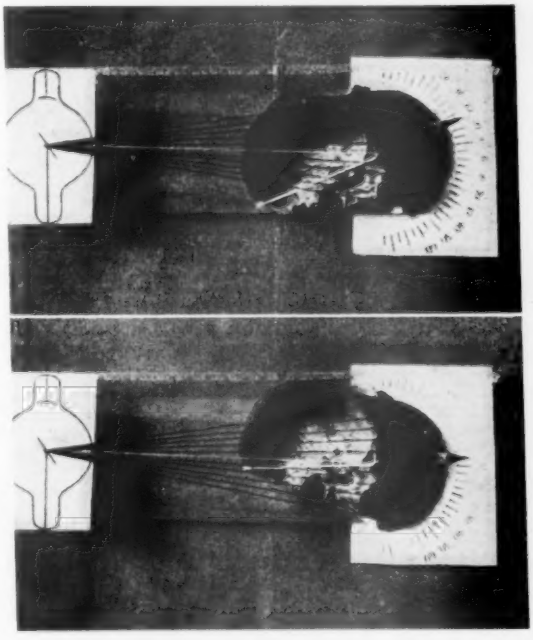

Fig. 5. Illustration for article on "Skiagraphy of the Frontal Sinuses" (1906).

absence of calculi, but their size, position, and number as well.

3. When a small calculus is shown in the ureter, the size and shape of its shadow will sometimes enable us to predict that it will be passed, and that operation for its removal will not be necessary.
4. Occasionally, conditions other than lithiasis will be indicated, such as tuberculosis, abscess, and diseases causing a change in the size, position, or outline of the kidney, or a fibrous thickening of the lower part of the ureter.
5. The X-Ray is not infallible and in incompetent hands it may be very misleading but under the best conditions it is exceedingly accurate.
6. The indications given by it often decide the important question of operation.
7. Such examinations should not, therefore, be undertaken lightly, nor intrusted to careless or incompetent persons, nor to those who have not the proper appreciation of the responsibility involved in deciding a question upon which may depend the health or even life of a fellow being.

Re-reading the conclusions we feel that they are as true today as they were twenty years ago.

In the *New York State Journal of Medicine* in 1909, there is an article by Caldwell giving a brief review of the application of the roentgen ray in diagnosis illustrated by reproductions of some of the plates which he had made. Many of the illustrations, made many years ago, would reflect credit on many an x-ray laboratory at the present time. In this article Caldwell points out very emphatically the first principle of roentgen diagnosis, namely, that the roentgenogram is not a picture but a special kind of projection and must be interpreted by one competent to so do. It is very delightful to read his conception of the rôle of the roentgenologist and I will quote one short paragraph from this article:

> The Roentgenologist who would excel must provide himself with the best possible equipment; he must acquire skill in the technique of using it; he must be painstaking in his observation of the plates; accurate but not over enthusiastic in his interpretation of them. His opinion should be valued rather than his so-called X-Ray pictures.

In 1910 there appeared a joint article by Eli Long and Caldwell on "The Relation between Carpal Ossification and Physical and Mental Development" published in the *American Journal of Diseases of Children*. This is an important article and one which has not received the attention which it deserves. The work was done at the Edward N. Gibbs Laboratory. The striking observation in this work is that in many of the children examined many discrepancies in the development between the right and left wrist of the same individual were observed, so the authors concluded that we must doubt the value of using a roentgenogram of the wrist as an accurate index of the development of any other part of the body. "Age, height, and weight increase in general with advance in carpal ossification, but with many exceptions among both sexes. We can find no relation between the degree of carpal development and quality of the mind."

Another interesting article which Caldwell published appeared in the *Journal of the American Medical Association* of November 3, 1917. This was "A Review of Five Hundred Roentgenographic Examinations of the Urinary Tract." In this paper he emphasizes the difficulty of obtaining reliable statistics of cases examined for a large number of physicians and surgeons owing to their incomplete records. He remarked on looking over the replies to his questionnaire, that the answers to these questions were purely suggestive and seemed to depend somewhat upon the weather or the state of digestion of the person answering.

The statistics which he developed showed an error of 2.4 per cent based on 290 cases, which is another index of the careful work which Caldwell did.

In 1914 in the *American Journal of Roentgenology*, Caldwell has an article entitled, "The Safe Interpretation of Roentgenograms of the Gall Bladder Region." In this article he indulges in justifiable criti-

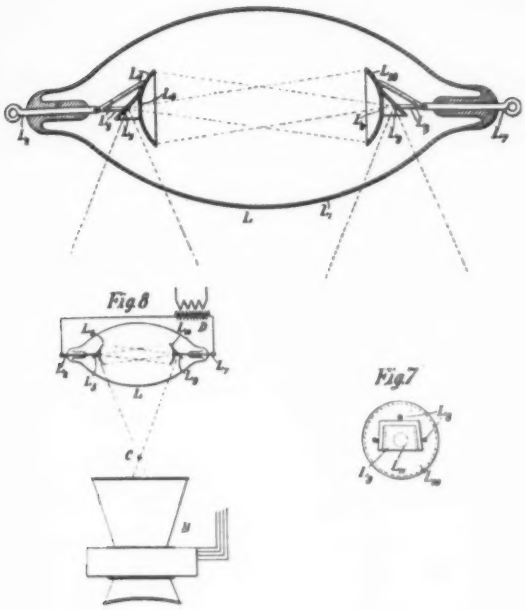

Fig. 6a. Very clever tube designed for stereoscopic work (designed in 1901) with two cathodes, behind each of which is mounted the anode for the opposite cathode. The cathode stream passed through the aperture in the cathode to the proper anode.

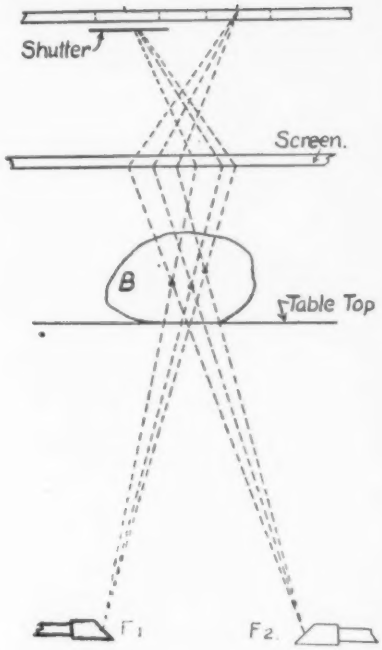

Fig. 6c. Optical principle of the stereo-fluoroscope. In rapid succession the roentgen rays issue first from F^1 and then from F^2. These two beams pass through the body, B, resting on the table top. The shadows are seen on the screen through the rapidly revolving shutter which opens and closes the apertures before the right and left eyes.

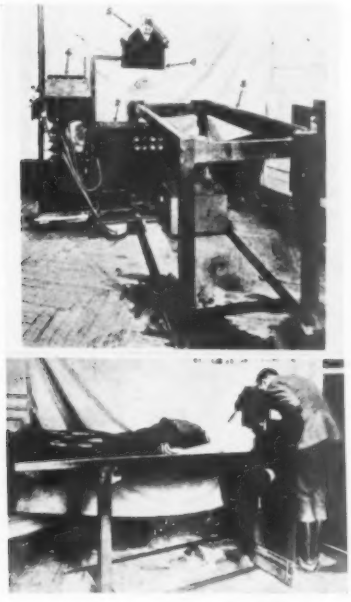

Fig. 6b. Stereoscopic fluoroscope table—top removed. Underneath is the transformer—above the box with twin tubes and a second box containing the automatic shutter; below, table in use.

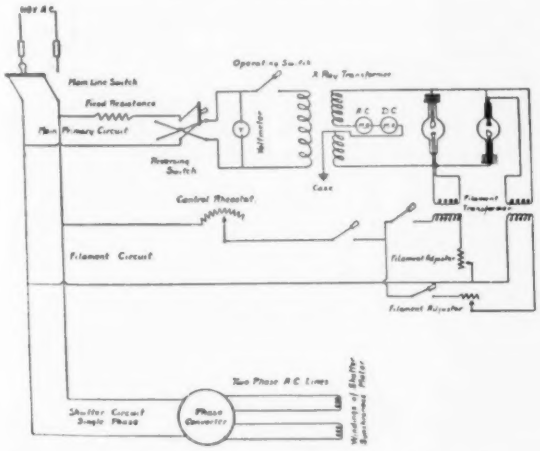

Fig. 6d. Wiring diagram for the stereo-fluoroscope.

cism of statistics showing the high percentage of successful diagnoses of gallstones. He points out that this difference in statistics is due to the temperament of the diagnostician as well as his skilled judgment. Speaking of the right upper quadrant he re-

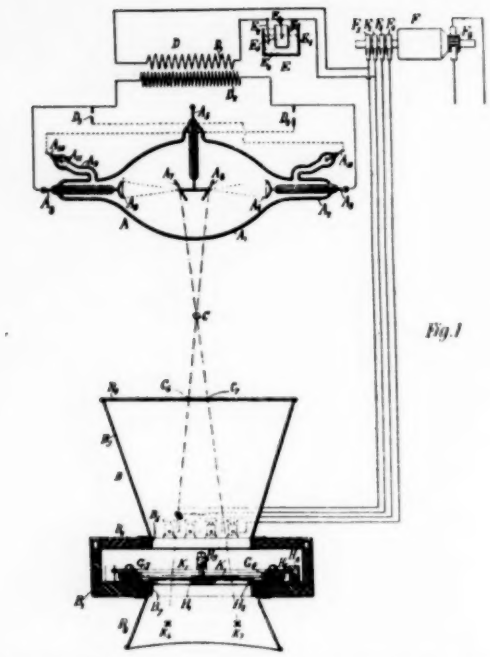

Fig. 1

Fig. 6e. Wiring diagram for the stereo-fluoroscope with stereoscopic tube.

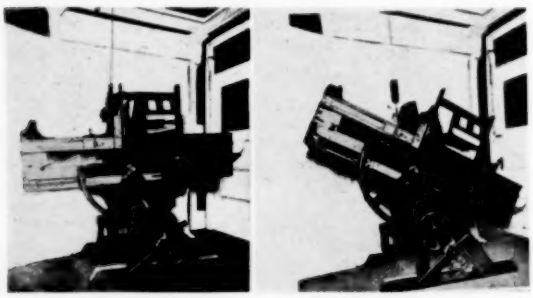

Fig. 7. Tilting table devised by Caldwell—operated electrically. There is a device on the side for holding the fluoroscopic screen. This is undoubtedly the prototype of many of the tilting tables on the market at the present time.

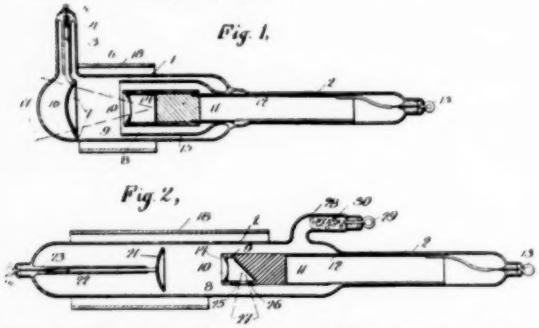

Fig. 1.

Fig. 2.

Fig. 8a. Drawings by Caldwell in 1909 of model of roentgen-ray tubes having recessed anodes to suppress the radiation except the primary beam.

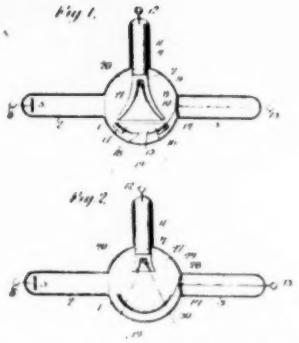

Fig. 1.

Fig. 2.

Fig. 8b. Another tube design by Caldwell (1913). Roentgen beam passes through an aperture in the hemispherical cathode from a deeply recessed anode.

marked, "It is in this danger zone that the number of killed and wounded resulting from faulty interpretation is greatest."

In "*Laryngoscope*" of November, 1908, Caldwell presented, "Further Observations

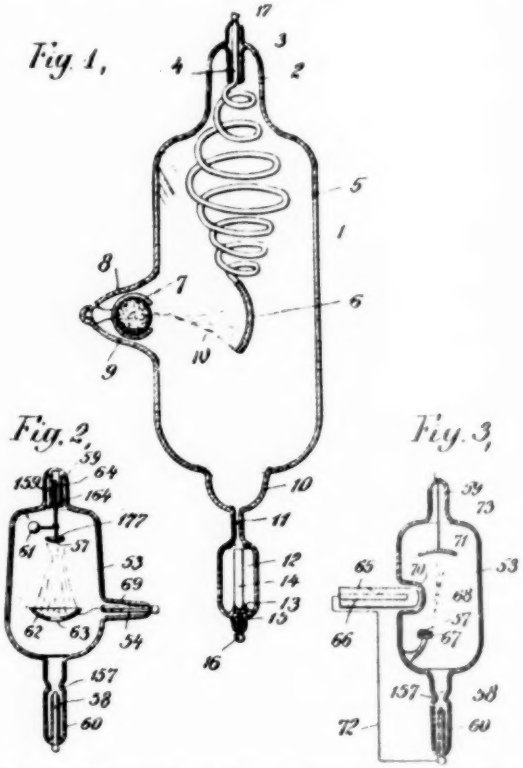

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 9a. Valve tube of Villard type designed by Caldwell (1913) with an automatic arrangement to regulate tube vacuum. This represents Caldwell's effort to obtain a reliable valve tube for a unidirectional non-fluctuating current to energize the roentgen tube.

on the X-Ray Examination of Accessory Nasal Sinuses." This was a very conservative article in which the difficulties of the new method of diagnosis are pointed out while emphasis is placed on the fact that inferior work in this particular field is of no value. The article is well illustrated with plates showing the application of the roentgen rays in the diagnosis of sinus disease. All through Caldwell's writings there is a tinge of humor and philosophy, as an example of which we would quote the following, taken from this article on sinus examination: "The AP projection requires a long exposure and is the one in which the operator is most likely to ruin his best tube and to lose that cheerful but dignified composure that should always characterize the medical man."

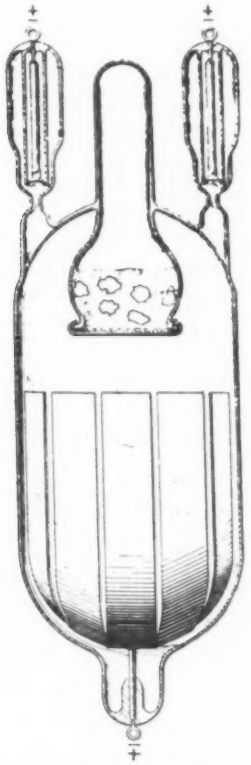

Fig. 9*b*. Later model (1916) of a valve tube by Caldwell. Cathode is composed of aluminum strips. The vacuum regulating chamber is separated by a metal membrane with a porous washer supporting the impregnated asbestos fiber.

In 1914, Clark and Caldwell published an article on "The Sella Turcica in Epileptics." This article, however, while containing a review of the literature does not present many decisive conclusions.

In reviewing Caldwell's work and measuring up the position which he attained, one is reminded of the story of the celebrated painter, who when asked what he considered were the three most important points which he would name as contributing to his success, replied: "First, technique; second, technique; and third, technique." The applications of this little anecdote are certainly well exemplified as we study Caldwell's part in the development of American roentgenology. Following his example, the technical difficulties which surrounded

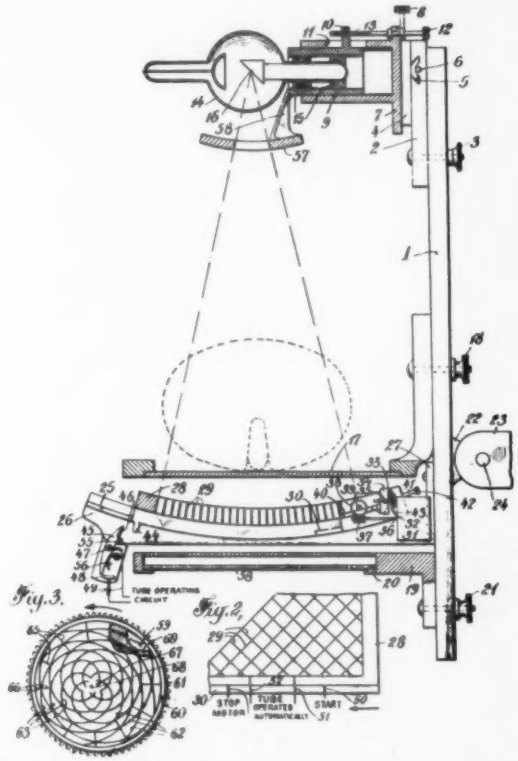

Fig. 10. Detail of tube stand and grid devised by Caldwell (1916) for support of the tube, fixed diaphragm (57), a rest for the body, and an oscillating or rotating anti-diffusing grid (29). This was so connected as to control the exposure time with the grid movement. On this the tube and plate holder were always centered. Such detail in arrangement of the diaphragms is characteristic of Caldwell's work.

our speciality have been carefully studied by many workers and the solutions of some of them, at least, have been quite satisfactory; a statement which should not be interpreted as meaning that all the problems have now been solved.

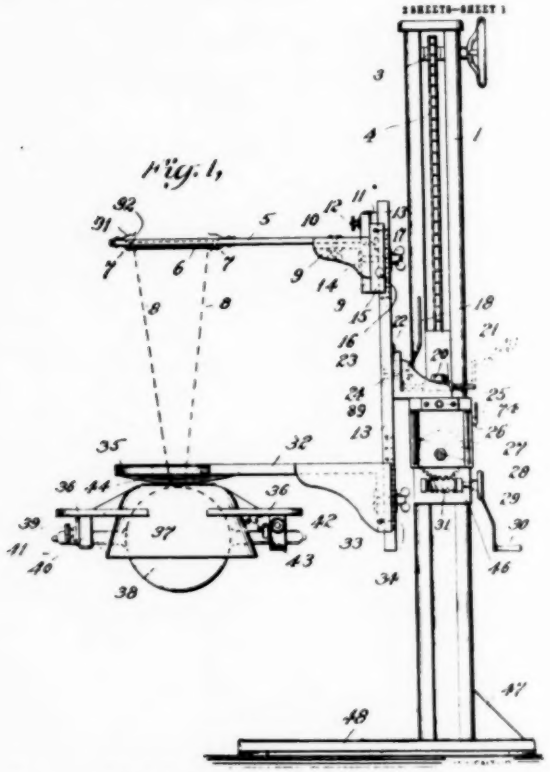

FIG. 11. Model of tube stand (1907) for suspension of an inverted tube. Caldwell used this method for filming and observing the position by means of a fluoroscope laid on top of the inverted plate holder after the patient had been exposed and before making the exposure.

I recall with pleasure one incident which showed Caldwell's genius in solving a technical problem. While I was visiting him, he showed me plates of a lateral projection of the head. As I looked at them I noticed the adequate penetration of the thicker parts of the skull and yet the thinner parts of the orbital and facial areas were not overexposed. In fact, one could make out the shadow of the lens of the eyeball. After expressing my astonishment at such an achievement, Caldwell finally remarked, "Well, it is very simple. By introducing a suitable wedge-shaped metallic filter of low atomic weight the inequalities of the exposure are compensated for by the retarding action of the thicker parts of the filter." This is a method which I think we do not make sufficient use of at the present time.

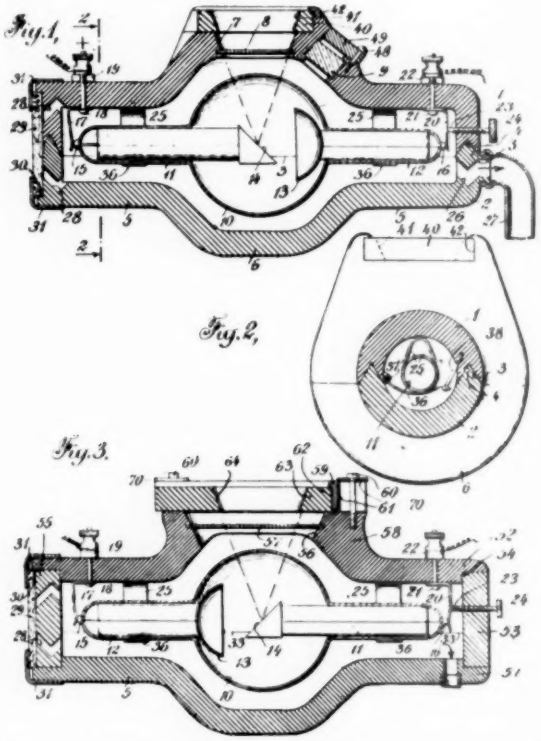

FIG. 12. (May, 1917) Enclosed tube holder made of material of highly insulating property even under considerable rise of temperature, provided with staggered inlet and outlet for the circulation of air in close contact with the tube. The insulating material suggested by Caldwell was bakelite or other phenol compound containing insulating material of lead, zinc, or other heavy material. The connections in this tube holder are made by spring contact which naturally facilitates the changing of tubes. It is provided also with a closable observation cover for inspection of the tube. The purpose of this device was to permit of the use of a much smaller roentgen tube inasmuch as the external cooling would obviate the necessity of having so much reserve space within the walls of the tube.

The speaker thinks it very appropriate at this meeting to voice the appreciation of roentgenologists of this and other countries to the founders of the Edward N. Gibbs Memorial X-Ray Laboratory. This was established in 1901 through the generosity of

Mrs. Gibbs. Dr. Caldwell served as the first Director continuing in this position until 1908. The generosity of the donors gave Caldwell a splendid opportunity to carry out his practical and experimental work. This Memorial Laboratory must therefore

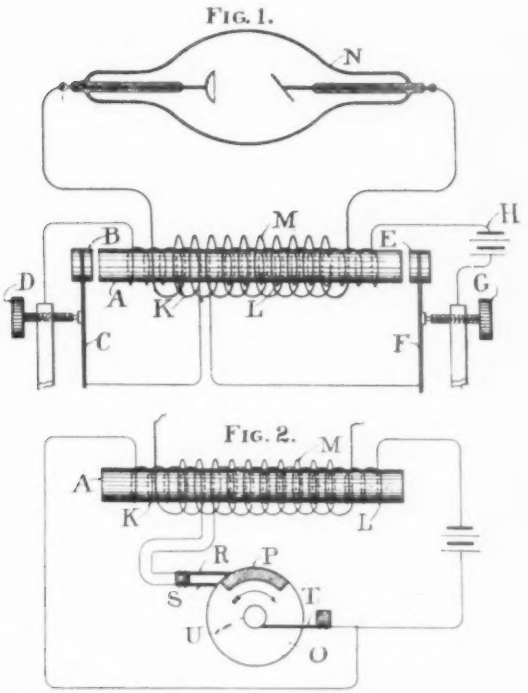

FIG. 13. (February, 1903) In the diagram of this arrangement of a tube and coil we find the armature with the primary winding L controlled in its make and break by the vibrating spring and armature F E. There is at the other end of the coil a secondary armature B, regulated by the contact screw D. This allows, after proper adjustment, of the auxiliary circuit being broken very slightly before the break occurs in the primary circuit and the auxiliary circuit is closed slightly before the primary circuit is closed, a device to minimize the inverse in the secondary.

In Fig. 2 of this design is shown another device for accomplishing the same purpose with a rotating interrupter which, after proper adjustment, accomplishes the same purpose, namely, to accentuate the make and minimize the break, tending in this way to minimize the amount of inverse, doing away with the necessity of valve tube for its suppression.

be considered as having played an important part in the development of the practical applications of radiation. This work is still being carried on through the generosity of the members of the Gibbs family.

In reviewing the outstanding constructive work of Caldwell we are again struck by a realization of the loss to roentgenology caused by his premature demise. The stereo-

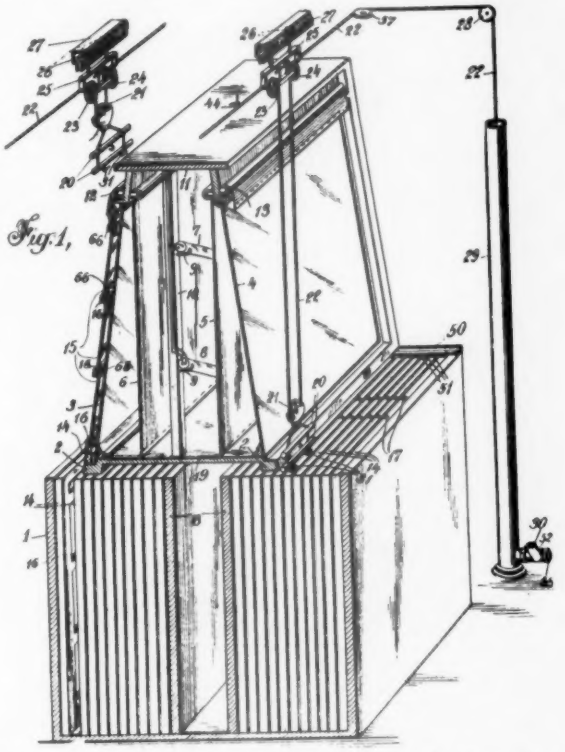

FIG. 14. (1916) Caldwell's apparatus for handling the heavy large glass plates and suspending them before the illuminating box. By this means all the plates on a certain case could be assembled in one of the metal frames and then handled as a unit.

oscopic fluoroscope (Figs. 6*a*, *b*, *c*, *d* and *e*) was rapidly approaching a successful termination. From a practical standpoint the stereoscopic fluoroscope is an instrument which should be in every large hospital. It is unfortunate that no one of engineering ability and financial resources has undertaken to continue the work which Caldwell so nearly finished. Electrical progress has gone on so that there are now satisfactory synchronous motors which would function as well for keeping in step the shutter of the stereoscope as they do in the shutter which has made television practical at the present time.

It would seem, therefore, that the influence of such a representative body as the American Roentgen Ray Society should keep the importance of this problem in the foreground in the hope that some engineer or some corporation will go on with the work where Caldwell left off. The application of such an instrument in the problem of fracture setting would alone warrant the time and effort which might be spent on the final solution of the problem.

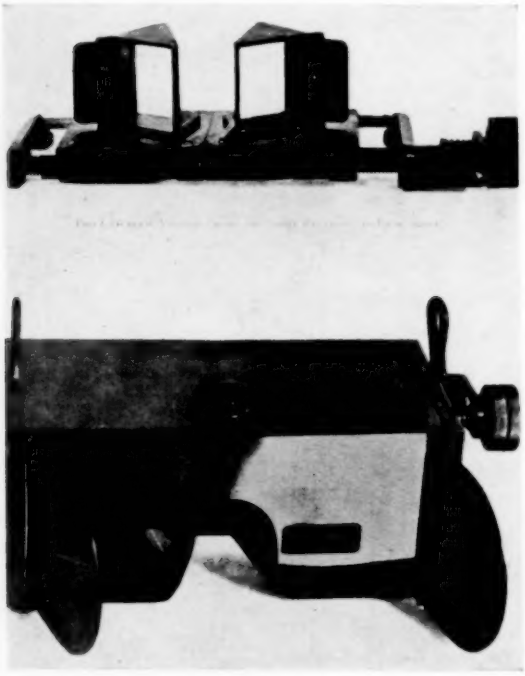

Fig. 15. Hand stereoscope which Caldwell devised for the inspection of stereoscopic plates. Plates are placed side by side on the illuminating box and the optical images are focused by the use of prisms, these prisms being held before the eyes. The screw on the right represents the device by which the angle of each prism was shifted to permit of blending of the images. On each side were provided wings for the extrusion of side light from the eyes. As this contrivance, on account of the weight of the prisms was somewhat heavy, Caldwell had an arrangement by which it could be suspended with a counterweight in front of the view boxes and could be shifted on a small overhead trolley so that it would center in front of any of the light boxes.

Applications of the Roentgen Ray in Otolaryngology

The fact that Caldwell first called the attention of the American profession to the advantages of the roentgen ray in the diagnosis of pathology in the nasal sinuses and the fact that he early devised a tube for the treatment of neoplasms in the pharynx and larynx, suggests to us that we consider for a very few moments the applications of the roentgen ray in otolaryngology. Caldwell's paper in 1906, dealing as it did with the anatomy and pathology of the frontal sinus, may be compared to a stone tossed into the still waters of the deep pool of science, the ripples of which have developed into ever extending waves covering the whole field of otolaryngology.

Caldwell's work on the frontal sinus has had very little added to it since his original communication. The position which he advocated has been found to be most suitable for general purposes of diagnosis.

In the examination of the maxillary antra the position advocated by Waters has been a distinct contribution and has become a routine exposure. The projection in another plane such as is obtained in the verticomental projection of the sphenoid is worth-while corroborative evidence. In the lateral projections the oblique angle recently suggested by Brown of Cincinnati may be of considerable advantage.

The study of the ethmoids may be carried out according to a variety of projections which have been suggested from time to time. The 23 degree angle of Caldwell and the usual lateral projection furnish views which are considered by many to be sufficient. However, the oblique projection advocated by Lang, Pfahler, and Rhese, especially if taken stereoscopically, is much better for information. For the posterior ethmoids the stereoscopic exposures with the technique of Van Zwaluwenburg are often very useful. The verticomental projection also if taken stereoscopically is corroborative evidence regarding the posterior group.

In the study of the optic foramina the technique advocated by Goalwin is very useful, the cloth skull cap on which the desired angles may be accurately marked out, helps much in this procedure as well as in certain other projections.

The sphenoidal sinus remained for a long time a region unexplored by the roentgenologist; the lateral projection gave the size and shape, but the superimposition of one sinus upon the other did not help much in the determination of sphenoidal pathology. The mentovertical and the verticomental projections, as advocated by Bowen and many others, when carried out with a careful technique, are extremely useful. The suggestion of Pfahler, using a special intraoral cassette, presents many advantages in selected cases. The work of Granger has simplified considerably the technique of many of these exposures, the Granger sinus board being now an indispensable part of the equipment of a roentgenologist interested in sinus study. Its use contributes much to the ease of securing accurate projection angles. The Granger projection for the demonstration of sphenoidal sinus disease is extremely useful, especially if the exposures are made stereoscopically, one exposure always being made according to the angle recommended, namely, 107 degrees. All in all, the technique has been perfected to an advanced degree.

It must be confessed, however, that there is still considerable criticism by the rhinologists on the work which is being done for them by the roentgenologists. In many cases this criticism is well deserved since it must be confessed that the indifferent and incomplete examinations which are sometimes made do not yield many conclusive data for the rhinologists. The proper roentgen examination of the paranasal sinuses demands a careful technique and a number of projections for satisfactory study of these cases. In addition, the interpretation should be done by one who has taken the trouble to study the pathology of the upper respiratory tract. A precise technique and an adequate knowledge of pathology will do much to silence the criticisms which are at present often well deserved.

The study of the mastoid received its start in American literature by the paper read by Sidney Lang in 1907. This created a startling interest in a new field of roentgen examination. The studies and wide clinical experience of Law, which resulted in his valuable monograph on the mastoid, have been of great value to the profession. In the field of otology the need of an exact technique has been further met by the publications of Pfahler, Granger, Hill, Bullitt, and Pancoast. The mastoid apparatus of Bullitt, while it imposes on the roentgenologist another special instrument, leaves little to be desired in the ability to realize and duplicate exact angle of projection, and furthermore contributes much to the comfort of the patient during the exposure.

In the roentgen study of the chronic mastoid one should not be content with the usual Lang or Law positions, but should be prepared to supplement the examination according to the Schüller technique, the Stenvers projection, or that of Mayer. The roentgen examination of the temporal bone is like a trip to Europe—one gets out of it results proportionate to the knowledge which he has before he makes the trip. The recent publications of Granger, and Mayer of Vienna are worthy of the most careful study. The paper of Schüller on "The Diagnosis of Acoustic Tumors" is of fundamental importance.

The field of roentgenology is now becoming so wide that the need of a certain number to specialize in the cranial fields is becoming more apparent. The general roentgenologist, like the general practitioner, must be an arduous and incessant student if he desires to keep abreast of the times.

In the study of the laryngopharynx it should be noted that the diagnosis of retropharyngeal abscess, either with or without bone change in the cervical vertebrae, is usually very decisive. The recent work of Reynolds along this line is deserving of note.

I shall not detain you with a discussion of the ability of the roentgen ray to determine

the presence or absence of foreign bodies in the upper respiratory tract. Thanks to the cooperation of the manufacturers of roentgen apparatus, the ability to take very rapid exposures of children has made this branch of the work much easier.

In the study of fractures of the bony framework of the upper respiratory tract, the roentgen ray has contributed much toward an exact diagnosis with consequent improvement in methods of treatment. Nasal and antral neoplasms are now better outlined as to the extent of their invasion of bony structures.

Following the tendency of modern science to visualize the various body cavities, experimenters made use of different substances for injection into the paranasal sinuses for the demonstration of their anatomy and an attempt to elucidate their pathology. In 1921 Hubeny employed a paste of barium sulphate for the injection of the sphenoidal sinus. Other substances have been used by other investigators but the injection material was usually found to be irritating and the technique somewhat difficult.

Iodized oil, more particularly lipiodol, after dilution with olive oil or liquid petroleum, proved to be a desirable injection menstruum. Reverchon and Worms published an article on this method in 1925. In 1926, Proetz in collaboration with Ernst published papers on "Sinus Mapping by the Displacement Method." Fraser of Battle Creek in 1926 and in 1927 published a somewhat similar technique for the study of the sinuses by the introduction of diluted iodized oil. These methods, while new, have in the hands of these writers and others, opened up a new method by which the roentgenologist in collaboration with the rhinologist can gain additional information concerning these concealed cavities. Like all new procedures when first brought out, there still exists a difference of opinion as to the value of the results obtained. The advocates of the method, however, have been very conservative in their claims and advise its use only in selected cases. Where the older methods of examination seem to prove inadequate in certain chronic conditions, recourse may be had to the roentgen ray and iodized oil for evidence of obstruction or filling defects. On account of the tolerance of the mucous membrane for the iodized oil, its use seems quite devoid of danger if a precise technique is followed. It is only fair to say that it promises well and may, like ventriculography and cholecystography, lead to a more exact method of diagnosis of sinus disease.

In considering the applications of the roentgen ray to otolaryngology, we might well take into account the aid which it has furnished in the study of the physiology of speech. In the first and second decades of the roentgenologic era, investigators turned their attention to the demonstration by roentgen plates of the position and contour of the tongue, the contour of the air content of the pharynx, the laryngopharynx, and the larynx. In order to visualize better the outline of the tongue, Barth and Grunmach made use of a small chain which was placed upon the top and base of the tongue and also upon the palate by being inserted through the nose. E. A. Meyer fastened small plates of lead on silk threads and laid these upon the tongue. Other investigators covered the lips, tongue, soft palate, and the posterior laryngeal wall with a thin coating of bismuth paste. While these expedients were all useful, many of the observers, notably Scheier, preferred the roentgen demonstration without the possibility of irritation of these foreign materials.

In studying the position of the larynx and hyoid bone the central ray should pass through the thyroid cartilage. In studying the various positions of the soft palate and of the tongue, the central ray should preferably pass through the angle of the mandible. The contour of the tongue is easily studied in contrasty films made with short exposure. In its posterior part there is a less pronounced contour due to the curving of the sides of the tongue in the phonation of vowels. The soft palate can be easily visualized and also the convexity of the posterior pha-

ryngeal wall, sometimes spoken of as Passavant's cushion. Of the structures in the laryngopharynx, the hyoid is always easily recognized while the epiglottis is easily studied with its curved contour.

The supporting cartilages of the larynx, namely, the thyroid and cricoid, show in direct proportion to their ossification. The Adam's apple of the male with its well-developed thyroid cartilage presents a distinction from the female larynx as well in the roentgen plate as by inspection. In films of the adult larynx one can usually tell at a glance the male larynx from the female larynx by observing the comparative calcification of the thyroid and cricoid cartilages. In the adult male the thyroid cartilage is well shown with the amount of lime appearing also as an index of the age of the patient. In the female, on the contrary, the thyroid cartilage is not prominent by calcification but the lime deposits in the cricoid are found to be quite advanced. These are present also in greater amounts during the latter decades of life.

Inasmuch as there are inherent difficulties in observing by direct inspection the position of the tongue, pharynx, and larynx during phonation, it follows that considerable light can be thrown upon the physiology of voice production by combining the roentgen investigation with other classical methods. Quoting from Scheier, we find that the mouth cavity in phonation of the vowel A has the form of a funnel widest in its anterior portion, while in the phonation of the vowel U we have a shape of the mouth cavity which corresponds with a rounded bottle with a long neck. The position of the soft palate also has been studied during the phonation of the vowels, its position being lowest with the vowel A and rising with the vowels E, O, and U successively, until with the vowel I it reaches its highest point. Quoting again from Scheier, whose dictum has been verified by the speaker, we find that the air-containing shadow of the nasopharynx is largest with A and successively smaller with E, O, U, and I.

Watching a singer with well-developed throat muscles, we note on inspection of the larynx that its position changes with the different vowels and consonants. This difference can be studied in better detail by films made during the speaking and singing of the different parts of speech. The researches of Haudek and Froeschels have been quite thorough upon this point, and in general are in accord with the findings of other investigators in this field. Naturally this systematic study of voice production has been of great interest to some of the teachers of singing. Spiess has noted that the palate has a middle position in M and N which allows part of the air to pass through the mouth cavity producing correct nasal resonance.

Naturally this method permits of the study of the position of the tongue and larynx in the characteristic sounds of different languages. The striking difference in the position of the tongue in the vocalization of the French vowels as compared with the English vowels can be utilized in demonstrating to students some of the fundamental principles in correct pronunciation. Eijkmann has made very exact studies of the movements of the larynx during humming and also during whispering.

Moller and Fischer have made precise studies on the position of the parts of the larynx during the production of falsetto notes.

Barth, Gutzmann, and Scheier each call attention to the value of roentgen studies in the teaching of singing, particularly in obtaining the correct position of the laryngopharynx. They point out that the so-called "singer's nodes" are produced because the base of the tongue is too closely in contact with the posterior pharyngeal wall. In connection with these studies the secondary studies upon the movements of the diaphragm during phonation receive a clearer explanation through the roentgen studies of this muscle.

Before I became interested in roentgen studies of deglutition, my ideas upon the physiology of one of the most common phenomena of the human body were extremely

hazy; since studying the act of swallowing with the roentgen ray, I have found in conversation with many physicians that their knowledge of the factors in the swallowing of a morsel of food was very inaccurate. Credit must be given to Eijkmann for his ingenious method of studying the roentgen appearance of deglutition. He constructed an apparatus with a small tambour placed against the larynx which would switch the current off and on during the movement of the larynx in swallowing. His conclusions can be briefly given as follows: first, occurs the movement of the tongue in which the bolus is propelled backward toward the posterior pharyngeal wall. As the bolus passes backward, the base of the tongue presses against the top of the epiglottis; the hyoid bone is drawn up by its hyoid muscles and approaches the base of the tongue. The hyoid bone and the larynx thus pressed together form a mass pushing up against the base of the tongue. This forces the epiglottis downward and causes the closing of the glottic opening. Only the laryngeal part of the epiglottis takes part in the closing of the larynx.

In the second part of deglutition the hyoid bone, the larynx, and the epiglottis are drawn somewhat forward and the tip of the epiglottis is pushed down along the posterior pharyngeal wall; the esophagus is open and the bolus leaves the region of the tongue, and aided by the pharyngeal constrictors passes over the epiglottis still pressed tightly over the opening of the larynx.

The third stage in swallowing is the relaxation of the tongue with the dropping down of the hyoid and larynx. This uncovers the larynx from its occlusion by the epiglottis.

Kraus and Kupferle made use of serial roentgen plates of the throat during the act of swallowing. Since the act of deglutition takes place so rapidly it has been found that it is difficult on the fluoroscopic screen to analyze the separate acts which take place so quickly. As the food passes down it does not usually pass directly over the larynx but during swallowing the valleculae of the laryngopharynx are filled and liquids fill each of the pyriform sinuses. We thus see that the complicated mechanism of swallowing, an act which usually lasts only a fraction of a second, has been very advantageously studied by means of serial roentgenograms.

It may be that the early studies of Caldwell on the direct photography of the fluorescent screen may, in the light of recent improvements in the speed of lenses, lead to simpler methods of studying the mechanism of phonation and deglutition.

A most important contribution to laryngography is the article on "Cancer of the Larynx in Roentgen Studies" by Hermann Liebermann of Moscow which appeared in the *Fortschritte auf dem Gebiete der Röntgenstrahlen* for June, 1927. This writer has had access to a very large quantity of clinical material, and studied by means of the roentgen ray over one hundred cases of laryngeal malignancy. His exposure technique was very simple, using a soft tube for the preservation of contrast. He calls attention to the greater frequency of cancer of the larynx in males than in females and his statistics show that it is most prominent between the ages of thirty-five and fifty.

The roentgen appearance of carcinoma of the larynx depends first, on the part of the larynx involved by the neoplasm; second, on the progress of the disease, and third, on the age of the patient. Neoplastic infiltrations and ulcerations of the epiglottis are strikingly well shown, as well as changes of contour of the aryepiglottic folds, the ventricles of the larynx, and the vocal cords. The important aid of the roentgen ray in studies of the larynx in cases of carcinoma is its ability to reveal changes in the cartilages of the larynx.

Liebermann quotes the classic descriptions of Schottelius on carcinoma of the larynx:

> When a tracheal ring is attacked the tumor simply envelops the cartilage and the latter is found unchanged imbedded in the neoplastic mass. When the cartilage is directly invaded by

the neoplasm the cartilage degenerates and there is seen present both a process of degeneration and regeneration. In this process lime is usually deposited and forms a bone-like tissue which gives rise to a characteristic appearance, a somewhat mottled shadow caused by areas deficient in lime and areas rich in lime.

The most marked change characteristic of cancer in the larynx as depicted in the roentgenogram is the so-called "granular shadow" where alternating light and dark areas are in juxtaposition. The encroachment on the air content of the laryngopharynx, changes in the ventricles of the larynx and trachea, are all of diagnostic value, indicating destruction of the epiglottis, the laryngeal cartilages, and the vocal cords. It therefore follows that careful study of these and other points of deviation from the normal may lead to diagnostic conclusions of strongly corroborative value.

After one becomes somewhat familiar with this appearance the diagnosis of laryngeal cancer can easily be made from the roentgenogram. It differs sharply in its appearance from tuberculosis of the larynx which will be discussed later.

In this article the above-mentioned writer describes several cases in which the roentgen ray was of service in indicating the extent of the invasion which was not so evident from the examination with the laryngeal mirror. The laryngeal mirror naturally gives a direct observation upon the condition of the mucosa of the larynx but does not and cannot give exact information as to the extent of the cartilaginous involvement. While Liebermann's article discusses principally advanced cases of cancer it must nevertheless be regarded as a most important contribution, inasmuch as it covers such a large number of cases. It describes, too, the characteristic roentgen findings in scleroma of the larynx, which is so much more common in women than in men, and which is quite amenable to treatment. A discussion also of benign tumors receives some attention but as these do not invade the laryngeal cartilages the use of the roentgen ray does not importantly supplement the ordinary direct laryngoscopy. Liebermann accentuates the point that the roentgen examination of the larynx should be supplementary to the other clinical methods of investigation and is most advantageous in the complete study of cases before operative procedures are contemplated.

In laryngography the importance of technique is necessarily to be emphasized. On account of the mobility during breathing and deglutition, the shortest possible exposure should be made with every effort to obtain a contrast in the soft tissues. The development of a soft tissue technique is here of the utmost importance. As in every other branch of roentgenology, a careful and thoughtful study of the films accentuates points of interpretation which at first seem to be of minor importance. Indifferent methods and hasty interpretation will yield only unsatisfactory results. It is not a subject which can be easily acquired as the amount of clinical material which falls to the lot of the usual roentgen laboratory is not sufficient to afford in a short time the needed experience.

The important laryngeal conditions which may be confused with one another are, of course, cancer of the larynx, tuberculosis of the larynx, and laryngeal syphilis.

We have discussed the roentgen appearance of laryngeal cancer and we will next take up the consideration of the roentgen appearance of laryngeal tuberculosis. The starting point for this study is in the publication of Schottelius in which he compares the cross-sections of the cricoid and arytenoid cartilages of a man twenty-one years of age who committed suicide, with a corresponding cross-section of the laryngeal cartilages in a tuberculous patient of twenty-one years of age. Whereas in the normal adult larynx the cross-section shows a normal tissue well supplied with blood vessels, we find in the laryngeal cartilages of the tuberculous patient a definite infiltration of the cartilage cells with fat and the mucous membrane containing many fat droplets. Both Schottelius and Thost point out that patients, such as those afflicted with gen-

eralized tuberculosis, show this same tendency to infiltration of the laryngeal structure with fat as part of the general cachexia. In the tuberculous larynx, in contrast with the normal, the tendency to osseous deposits is not found. This is the histological explanation of the process seen in the roentgenogram of the tuberculous larynx. Thost relates that in the first exposures which he made of laryngeal tuberculosis, he was very much dissatisfied with the lack of contrast which he obtained until he learned that this lack of contrast was the typical and characteristic appearance of this condition.

The investigations of Schottelius show that the nutritional changes in the larynx of a tuberculous patient must be regarded simply as an index of the general condition from which the patient is suffering, even before there is a direct invasion of the larynx. As in carcinoma of the larynx the roentgen ray will register the destructive changes wrought by tuberculosis in the laryngeal structure. Changes in the epiglottis are very easily recognized on account of the background of air in the laryngo-pharynx. Changes in the vocal cords which are attended with macroscopic deviations in outline naturally affect the outline of the air content of the ventricles. When the changes in the true and false vocal cords are advanced, if the process is hyperplastic, there is obliteration of the air spot which is so characteristic of the ventricles. The great help of the roentgen ray in the study of the tuberculous larynx is in the registration of the condition of the cartilages. While the laryngeal mirror will portray the macroscopic changes in the mucous membranes, particularly over the arytenoids and the true and false vocal cords, still the mirror will not show directly anything with regard to the infiltration of the cartilages. In this respect the roentgen ray affords considerable aid in the study of the pathology of laryngeal tuberculosis.

Benign tumors of the larynx both of the papillomatous and verrucose type usually occur on the vocal cords. In a rapid lateral exposure of the larynx the clear spot shown as the pocket of air in the ventricle is bounded on its lower border by the true vocal cords and on its upper border by the false vocal cords. It frequently happens, therefore, that when inequalities occur upon these vocal cords the laryngeal plate will show a deviation in outline of the usual smooth surface of the true cord. Naturally this does not give the precise information afforded by the laryngeal mirror or the laryngoscope but simply presents another method of studying laryngeal pathology.

It is possible also to study gouty manifestations in the larynx. The most frequent sites of gout of the larynx are the joints between the cricoid and arytenoid cartilages. Thost has devoted considerable time to the study of this condition and he has never missed noting a pronounced calcification of this joint in well-established cases of gout. Rethi has studied this and other conditions of the larynx by an ingenious, but somewhat impractical method of an anteroposterior projection with the film placed behind the larynx and within the esophagus.

In concluding, we should remember that biography, like history, has its greatest value in the lessons to be learned from its study. This evening we have been following the life history of one whose developmental work in our specialty has been of the utmost importance. In closing this somewhat hasty sketch of Caldwell's work we feel that certain important deductions can be drawn from a study of his methods. Caldwell was, first of all, thoroughly prepared for the work which he undertook. His electrical and physical training fitted him for the study of the electrical problems which early presented themselves. When he found that his lack of medical knowledge was a marked handicap in his professional career, he set out at once to supplement his training. Like Walter Dodd, he filled in the gap by the hardest kind of work and persevered even under a staggering load. Too many of us, I fear, are content to go along our daily work handicapped

by a lack of electrical physics and serenely content to read and speak but one language.

Caldwell was an idealist. One feels that his constant thought was to better the conditions under which he worked. He was continually seeking after a better type of tube. He was not content to see only patients who could go to his office, but devised means by which the roentgen ray could be brought to the bedside of those who often needed its use more than the ambulatory patient. He was not satisfied to work with the somewhat imperfect tools bought from the manufacturer but was constantly occupying himself with the problem of bettering the implements of his profession. Following his example, if we are not satisfied with what we can buy, we should not indulge simply in destructive criticism but we should study the problem and make use of constructive methods.

Caldwell was his own severest critic, and never allowed himself to be satisfied with what his own studies told him to be short of the best.

He was a true idealist because he was not concerned with self-aggrandizement but was actuated by a genuine desire to find the truth and to be of service. His work was on such a high plane that his services were constantly sought after. The speaker's task will not have been in vain if you who make up this assembly are strengthened and encouraged by the glimpses which we have had of one who so nobly exemplified the ideals of our specialty.

INTRAVENOUS UROGRAPHY*

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THEORETICALLY, it would hardly seem possible that any substance injected intravenously could be secreted by the kidney in such a concentrated form as to cast a shadow of the renal pelvis and ureter in the roentgenogram. However, in 1923 Rowntree and his associates, Osborne, Sutherland and Scholl, at The Mayo Clinic were the first to show that the renal pelvis and the bladder could be outlined following intravenous injection of large doses of sodium iodide. Not alone did Rowntree and his associates demonstrate the feasibility of outlining the upper portions of the urinary tract by this method, but they also indicated the possibility of similarly rendering other organs visible in the roentgenogram, specifically referring to the liver, vascular system and spleen. Their suggestions were soon followed by the demonstration of cholecystography by Graham and Cole.

The greatest objection to solutions of sodium iodide was the fact that the iodine in its inorganic form was poorly tolerated and did not permit of greater concentration in the urine. It was necessary to find an organic form of iodine which would have none of the toxic qualities of inorganic iodine and which would be secreted in higher concentration. This was accomplished by Roseno, who described a substance in which iodine was combined with urea and which was secreted in sufficient quantity to outline clearly the renal pelvis in many cases. Soon afterward, he reported his experience with a series of patients who had a variety of lesions; he thoroughly evaluated the method and placed it on a clinical basis. However, the substance was toxic to some patients and consequently did not meet with general acceptance.

An iodine derivative of pyridine in high concentration had been previously discovered by Binz and Räth of Berlin. This was called "Selectan Neutral," and was intended to be employed intravenously as an antiseptic of the urinary and biliary tracts. It was employed for this purpose experimentally by Lichtwitz, of Altona, who discovered that it was largely excreted n the urinary tract. Swick, of New York, working with Lichtwitz, recognized the potentialities of the selectan group as a contrast medium in intravenous urography and deserves much credit for its development. However, it proved to be toxic in some cases and the shadow of the renal pelvis was frequently uncertain. Working with Swick and von Lichtenberg, Binz made various modifications which obviated the objectionable features, leaving a substance 2-oxo-5iodo-pyridine-N-acetate which was called uroselectan. Von Lichtenberg insisted on exhaustive trial of the substance by a group of representative American urologists before it should be distributed for general use, and the results obtained by these urologists were submitted at a recent meeting of the American Urological Association. Thus, the discovery of Rowntree and his associates was placed on a more practical basis and it is now possible to employ intravenous urography with a reasonable degree of success.

Since uroselectan has been widely employed for almost a year, one may consider what the verdict is in regard to its practical application. It has been the experience of most observers that it is undoubtedly a valuable addition to methods of diagnosis of diseases of the urinary tract. It has been demonstrated that it often can reveal lesions in the urinary tract or result in their exclusion from consideration without cystoscopic or other data. However, it is also recognized that the method has certain defects which will restrict its universal employment; these I shall consider in detail.

* Read at the Thirty-first Annual Meeting, American Roentgen Ray Society, West Baden, Ind., Sept. 23–26, 1930.

In the first place, the clinical value of the intravenous urogram depends largely on the accuracy of its interpretation. Unless the interpretation is based on thorough knowledge of the various changes in the outline of the renal pelvis and ureter caused by different types of disease, it is worse than useless. Such knowledge can be acquired only through wide experience with urography. Without knowledge of the interpretation of the urogram one might easily be led into error. Unilateral absence of any outline of the pelvis, or the outline of a large, sacculated kidney is easily recognizable (Figs. 1 and 2). In other than these two extreme conditions accuracy of interpretation will be possible only to those who have thorough knowledge of the normal and the diseased pelvis. Furthermore, the intravenous urogram is usually insufficient in itself to allow the exact condition in the urinary tract to be ascertained. Although there are a number of cases in which indications for or against operation or other forms of treatment can be ascertained with the intravenous urogram alone, in the

Fig. 1. Intravenous urogram: large pelvis of solitary kidney. Good detail in intravenous urogram.

Fig. 2. Retrograde urogram: large pelvis of solitary kidney; poor detail.

Fig. 3. Intravenous urogram: bilateral hydronephrosis; larger on left. Stone 1 cm. in diameter in left renal pelvis, secondary. Cystoscopy was necessary to rule out obstruction in ureter, which is not visualized; also differential function to determine which was the better of the two kidneys.

great majority of cases other data, such as may be obtained through cystoscopic examination, renal functional tests, bacteriologic studies, and so forth, are necessary to clinical accuracy (Fig. 3).

Some patients react severely to administration of uroselectan. The symptoms complained of may be intense bodily heat, throbbing, nausea, headache, choking sensation, severe pain in the arm, dysuria, or general malaise. Although in many cases the symptoms are fleeting and easily forgotten, in others they are so severe that some patients who have experienced both methods say that cystoscopy and retrograde urography are preferable to the intravenous method. In spite of the fact that the iodine is organically combined in uroselectan, it will be found that the reactions usually occur among patients who have an idiosyncrasy to iodine. Attempts have been made to overcome these subjective symptoms by slowing the rate of injection and by administering smaller amounts, but little reaction is usually noted until after

Fig. 4. Intravenous urogram: both pelves rather dim. Urogram made to identify tumor in left upper quadrant. Owing to lack of detail, this was impossible.

Fig. 5. Retrograde urogram: normal pelvis and ureter, definitely identifying the tumor as extrarenal.

20 gm. (50 c.c.) of uroselectan have been injected. It should be stated, however, that these reactions are largely of historical interest, since the use of smaller dosage and newer mediums such as skiodan, have largely eliminated them.

Among the criticisms made of the use of uroselectan is the frequency with which the outline of the pelvis is so dim that exact interpretation is difficult or impossible (Figs. 4 and 5). Not alone is the intravenous urogram frequently dim, but in many cases the renal region is obscured by a large amount of gas in the bowel. This occurs so frequently following administration of uroselectan that it would seem possible that the substance so diminishes peristalsis that accumulation of gas results. Attempts have been made to increase the density of the outline by the following methods: (1) increasing the amount administered from the original amount of 40 gm. to 60 gm.; (2) reduction in intake of fluid prior to injection and exclusion of any diuretic; (3) keeping the bladder distended, so that the urine will be retained in the ureter and pel-

vis by back-pressure; (4) application of bags along the course of the lower part of the ureter to cause occlusion, and (5) placing the patient in the Trendelenburg position to favor retention of fluids in the kidneys and ureters.

My experience has been that the intensity of the urogram is not always increased by injecting larger amounts of the medium; furthermore, that the reactions are often markedly increased. Some of the films have been remarkably clear after injection of 20 gm. of uroselectan instead of the usual 40 gm. This difference in ability to secrete iodine by apparently normal kidneys is difficult to explain. Concentration of urine by limiting intake of fluid and exclusion of diuretics usually will increase urographic visualization. Better results may be obtained by retention of iodine in the renal pelvis and ureter as a result of obstructing the lower part of the ureter with compression bags during a short period before exposure.

There does not seem to be any advantage in taking a large series of films over many hours, unless it is desirable, in doubtful cases, to determine the presence or absence of stasis. A film taken, for example, within fifteen minutes, and one taken approximately forty minutes later are usually sufficient to give satisfactory urograms whether renal elimination is rapid or slow.

Possibly the greatest value of intravenous urography to the urologist will be (1) in cases in which cystoscopy or ureteral catheterization is inadvisable or impossible, and (2) in giving data complementary to those obtainable by cystoscopy and retrograde urography. Attention has already been called by various observers to the value of intravenous urography in cases in which cystoscopy and ureteral catheterization are inadvisable because of the patient's age, weakness, and so forth, or in which it is impossible because of deformity, intolerance, anomaly or other conditions. It is obviously preferable to cystoscopy and ureteral catheterization in children, although the necessity of giving anesthesia in younger children prevents its routine application and reduces its comparative value.

Intravenous urography frequently offers valuable data to the surgeon in the presence of extensive vesical neoplasm, enabling him to determine the condition of the ureters and renal pelves and the advisability of attempting ureteral transplantation. Similarly, with marked intravesical enlargement of the prostate gland, the presence of extensive ureterectasis or pyelectasis may influence the advisability of prostatectomy and the necessary after-care. The value of the method in determining the condition of the renal pelvis and ureter following operation, such as with plastic operation on the kidney, extensive pelvic operation with possible injury to the ureter, and so forth, is obvious. It is particularly valuable in determining the condition of the kidneys prior to and following operation for exstrophy of the bladder. Impassable obstruction to the ureteral catheter, of unknown or doubtful nature, is frequently observed. The problem can best be illustrated by those cases in which the ureteral catheter meets with impassable obstruction near the ureteropelvic juncture and in which no evidence of a medium above this point is discernible in the retrograde urogram. Such obstruction might occur with hydronephrosis, tumor, stricture, spasm, anatomic deformity, lithiasis, and so forth. The intravenous urogram usually will outline the pelvic deformity and often will indicate the nature of the lesion.

ESTIMATE OF VALUE IN PARTICULAR FIELDS

General Diagnostic Measure. A survey of my experience with intravenous urography would show that it is of the greatest value in the demonstration of stasis. As a result of stasis, with retention of iodine, the dilated pelvis or ureter is clearly outlined, if renal excretion remains adequate. In fact, unless there is stasis, the outline of the pelvis and calices is frequently disappointing in its lack of detail. It is often neces-

FIG. 6. Intravenous urogram: excellent visualization, but inspection of calices shows slight deformity in lower on right; not sufficiently clear to make definite diagnosis.

sary to be content with making interpretation on the basis of a partially filled pelvis, with the outline of one or more calices missing. When minor deformity is present, one is frequently surprised at the difference between the appearance of the pelvis in the intravenous and retrograde pyelograms. The latter is usually far better in detail and permits of greater accuracy in interpretation (Figs. 6 and 7). With stasis, however, the outline of the calices and pelvis is frequently quite distinct and the diagnosis of the various types of pyelectasis and ureterectasis can be made readily. The method is particularly valuable in general diagnosis because of its ability to visualize that important condition known as intermittent hydronephrosis, which is so frequently overlooked. The dilated pelvis is usually clearly visualized, in striking contrast to the normal pelvis on the other side. The intravenous urogram usually will be found more accurate in determining the extent and outline of a large hydronephrotic sac than the retrograde pyelogram. With hydronephrosis of moderate degree, the detail is often better with retrograde pyelography. Yet I have observed several instances in which the calices did not show much evidence of pyelectasis in the retrograde pyelogram, whereas in the intravenous urogram the dilatation of the calices was so marked that the urogram appeared to be of a different pelvis. Furthermore, intravenous urography offers an advantage in that it outlines the site of ureteral obstruction more accurately. The determination of this factor may alter materially the treatment indicated, particularly if the obstruction occurs in the lower part of the ureter, and has resulted in ureterectasis. In minor degrees of pyelectasis, in which the appearance may be confused with that of a large, normal pelvis, there is, as a rule, delay in drainage, which can be determined by delayed urograms. Intravenous urography also has great advantage, in that both renal pelves are visualized. In the presence of unilateral hydronephrosis I formerly hesitated to make a bilateral retrograde urogram because of the possibility

FIG. 7. Retrograde urogram: right pelvis more clearly visualized, as well as deformity of lower calix, giving better detail.

of retention of medium in a hydronephrotic sac on the opposite side. Intravenous urography permits of bilateral pyelograms without danger. Visualization of both kidneys as a routine has demonstrated that hydronephrosis occurs bilaterally much more frequently than previously had been supposed. As a rule there is marked difference in the degree of pyelectasis in the two kidneys; the pelvis on the side to which symptoms are referred usually is much larger than the other.

Hydronephrosis may be present with conditions other than ureteral obstruction. Variable degrees of pyelectasis may occur secondary to a variety of renal lesions, such as tuberculosis, polycystic kidney, renal neoplasm, lithiasis, anomaly, and atonic conditions of the ureter and pelvis. It is of great clinical importance to recognize the underlying lesion. When pyelectasis occurs with such conditions as polycystic kidney or anomaly, surgical treatment may not be indicated. With other conditions the type of operation indicated would vary with the primary lesion present. It is evident, therefore, that a diagnosis of hydronephrosis without qualifying it by determining the etiologic factor often would be incomplete. The various cystoscopic data and differential renal functional tests are essential in completing the diagnosis.

Renal Lithiasis. Intravenous urography promises to be of great value to the general medical profession in the diagnosis and treatment of renal lithiasis. It has been my experience that it has been of particular value in (1) identification of shadows; (2) their intrarenal localization; (3)ascertaining the function of the two kidneys separately; (4) demonstration of coincident disease or anomaly in the affected kidney, and (5) determination of the functional capacity of, and disease or abnormality in, the other kidney than that to which symptoms are referred.

Shadows which on interpretation of the original film are seemingly intrarenal or extrarenal often will be shown by intravenous urography to be the opposite. Frequently when small stones are present, however, the lack of detail in the intravenous urogram will not permit of identification. In doubtful cases, both retrograde and intravenous pyelography should be employed. In the majority of cases of intrapelvic stones there will be evidence of stasis, as shown by a variable degree of pyelectasis; as a result the affected pelvis, and often the ureter, may be more clearly outlined than those on the opposite side. This may be shown more clearly in delayed films.

Intravenous urography offers certain advantages in determining the site of intrarenal shadows, because the density of the pelvic shadow is usually less than that of the calculus. As a result of this the outline of the calculus often can be seen through that of the pelvis. It is of particular value in cases of stones situated in the ends of the calices, since it gives a better idea than retrograde urography of their exact position and the feasibility of their removal.

Intravenous urography gives evidence which leads to the belief that bilateral involvement of the kidneys occurs more commonly than previously was supposed. It is surprising how often evidence of minor abnormality such as stasis in the calices, or slight clubbing, is observed in the pelvis of the kidney opposite to that to which symptoms are referred. This might be due to previous pyelonephritis and secondary cicatricial changes, or it might be the result of abnormality left by stone which was formed and previously passed. Visualization of other underlying abnormalities which occur with stone, such as anomaly, is of the greatest clinical importance.

Intravenous urography may be of particular value in the identification of shadows in the region of the ureter. It is well known that retrograde urography is sometimes followed by considerable reaction when the stone obstructs the ureter. Intravenous urography obviates this and often gives diagnostic data which may not be obtainable with retrograde urography. It is of considerable value in determining renal

function and the degree of pyelectasis above the stone; this may be impossible by the retrograde method. It is particularly valuable in cases of impassable obstruction to the ureteral catheter and in cases of stone impacted in the lower portion of the ureter. In many cases, however, the lower part of the ureter cannot be satisfactorily visualized in the intravenous urogram, so that interpretation of shadows in that region is unsatisfactory, and retrograde urography will be necessary.

Anomaly. Renal anomaly undoubtedly will be discovered more frequently on clinical examination in which intravenous urography is used as a routine, than previously was possible. Unless bilateral pyelography was employed, fused and ectopic kidneys and pelvic duplication were frequently overlooked. Since there is frequently a minor degree of stasis in the pelvis of a fused kidney, it is usually well visualized. Duplication of the renal pelvis is undoubtedly frequently overlooked unless one is sufficiently familiar with the outline of a duplicated pelvis to realize that the presence of a second pelvis is suggested. Visualization of both pelves should be of considerable practical value, but it should be remembered that in the diseased half of the kidney there may be insufficient secretory ability for the pelvis to be outlined. Demonstration of duplication would be of particular value in the interpretation of shadows suggestive of stone in the renal or ureteral regions, which might otherwise be overlooked. Unfortunately, however, the ureters are frequently not clearly outlined unless there is stasis. This is particularly true of the lower part of the ureter, and it may be difficult to determine whether or not there is complete duplication.

Renal Tumor. Intravenous urography has been disappointing in the outlines which it has given of the deformity which occurs with renal tumor when the pelvis is but moderately involved. Deformity of minor degree, in the calices or pelvis, such as usually accompanies tumor in its early stages, is frequently too dimly outlined to be of diagnostic value. With advanced tumor, and when there is stasis, deformity from tumor may be recognized; this may be particularly applicable to primary neoplasm of the renal pelvis. As a result of lack of detail, it may be difficult to identify the various types of renal neoplasm and to distinguish them from solitary cyst, polycystic kidney and deformity caused by extrarenal pressure. Deformity accompanying polycystic kidney also may be insufficiently outlined to be recognized unless there is stasis with elongation of the calices to identify the lesion. As a rule, therefore, with suspected tumor it is advisable to make a retrograde pyelogram in order to get more accurate detail.

Renal Infection. Minor deformities of the pelvis and calices, caused by chronic infection of the kidney, are frequently obscure in the intravenous urogram and difficult to recognize in the absence of stasis. The method is particularly disappointing in revealing early and moderate degrees of deformity accompanying renal tuberculosis. When the process has advanced to cause definite deformity such as that seen in necrosis or pyelectasis, the intravenous urogram may be of greater clinical value than the retrograde pyelogram. The secondary deformities of the ureter which accompany tuberculosis are also frequently poorly visualized unless there is stasis. When deformity due to chronic pyelonephritis or tuberculosis cannot be identified by other measures, and urography is indicated, retrograde urography is usually preferable, as it is if neoplasm is present.

Physiology of the Ureter. Among the valuable contributions of intravenous urography undoubtedly will be the data that it gives in regard to the physiology of the ureter. It has already disclosed many new data concerning the dynamics of the ureter. It has shown clearly that segments of apparent narrowing and dilatation in the ureter are caused by peristalsis. When excessive, these may simulate actual constriction or angulation of the ureter. It has emphasized the importance of recognizing

atonic dilatation in contrast to that resulting from obstruction, and has given additional data for their differentiation. With obstructive dilatation, the entire ureter above the constricted segment usually is involved. Atonic dilatation usually is more limited in extent, although the entire ureter may be irregularly involved. It frequently will be confined to a limited portion of the ureter, leaving the portion above it abruptly normal in caliber. In several cases in which cystography gave evidence of ureteral reflux and of the entire or partial dilatation of the ureter, that often occurs with atony of the ureter, the intravenous urogram gave evidence of stasis and outlined the dilated ureter equally well. With hypertrophy of the prostate gland the intravenous urogram will give evidence of dilatation in the ureters more frequently than it had been supposed to exist. Such ureterectasis is usually atonic in type, although in some cases it may be due in part to obstruction.

Test of Renal Function. One of the most valuable features of intravenous urography is its ability to give visual evidence of the degree of renal function. If the renal pelvis and calices are clearly visualized within ten or fifteen minutes after intravenous injection of organic compounds of iodine, it is safe to assume that the renal function is within normal limits. This factor is of self-evident value, particularly in cases in which one of two kidneys requires surgical operation, and it is desirable to know the degree of function of the other. It can usually be inferred, also, that if visualization of the renal pelvis is not possible within an hour after injection the function of the kidney is either temporarily or permanently destroyed. It has been found, however, that absence of a shadow does not always indicate that renal function has been permanently destroyed and that failure in excretion of iodine does not identify the cause of disturbed renal function. Lessening the value of the test of renal function by visualization are such factors as stasis, technical difficulties, poor preparation of the patient, obesity and deformity. Lack of visualization may mean either a nonfunctioning kidney, temporary inhibition of its function, or absence of the organ. In spite of the possibility of such error, renal visualization usually gives a more accurate and satisfactory test of renal function than tests formerly employed. This is particularly true in the presence of renal calculus which causes reflex disturbance of function, resulting in misleading renal functional tests. That the reduced function may be a reflex effect of irritation caused by the cystoscope and ureteral catheter rather than being due to the stone itself may be inferred, since usually no disturbance of function is evident on visualization in the course of intravenous urography. Occasionally, however, irritation from a pelvic stone may interfere with visualization in the intravenous urogram and may simulate renal destruction, as was noted in two of our cases. Visualization of a renal pelvis containing a stone may be accentuated as the result of urinary stasis and it would then not serve as an accurate index of secretory ability. When there is marked destruction of the renal tissues as the result of stone, visualization will be diminished, or even a shadow may not be visible; this serves as a guide to the operation indicated. It is evident, therefore, that although the degree of visualization is a fairly accurate index as to renal function, nevertheless in case of absence of a pelvic shadow, cystoscopic data may also be necessary. The relative degree of renal excretion has also been estimated by determining the amount of iodine excreted in the urine, either by means of chemical tests or by determining the specific gravity of the urine. In the normal kidney, the specific gravity will increase in degree relative to the amount of iodine excreted and will often reach 1.045 or more.

Medium for Retrograde Pyelography. One of the greatest advantages that the introduction of organic compounds of iodine has given is their value as a medium for retrograde pyelography. The comparatively

FIG. 8. Intravenous urogram: average visualization.

large content of iodine in a combined form gives a medium which casts a dense shadow and causes less local irritation than any other hitherto suggested. Irritation of the kidney is observed less frequently than with solutions of sodium iodide, even though the uroselectan may be retained for several days in the renal pelvis. Because of lack of irritation it can be used for bilateral pyelography with less danger. It has the additional advantage of adhering to the wall of the ureter, so that it gives a much better ureterogram than the mediums previously employed. It also offers an excellent medium for pyeloscopy in that the irritating qualities of free iodine are largely obviated. That it may occasionally cause trouble, however, when retained in a dilated renal pelvis, is shown by two cases of hydronephrosis which we observed at operation, in which evidence of acute cortical infection was present. It is not frequently employed in cystography, because of its cost, and since it occasionally causes irritation of the bladder. The original cost of uroselectan can be reduced by recovering what is excreted in the urine following intravenous urography, as suggested by Osterberg. The urine is saved for several hours following intravenous urography, since the bulk of the uroselectan excreted in this time is in a comparatively concentrated form. The uroselectan is then reduced from the urine and purified, and is fully as good as the original substance when employed as a solution for retrograde pyelography (Figs. 8, 9, 10 and 11).

COMMENT

Finally, it should be stated that the last word has not been said on intravenous urography. Uroselectan will undoubtedly be only a forerunner to mediums of greater excellence which soon will be developed. The ideal medium will be one which causes no subjective symptoms and which can be given in smaller quantity and orally as the dye is given for cholecystography. Greater

FIG. 9. Retrograde urogram: left pyelogram shows much clearer detail of calices and pelvis. Outline of the ureter, however, more accurate in intravenous urogram, showing ureterectasis in lower portion of the ureter.

clarity of visualization will also be essential, so that delineation of the minor deformities in the pelvis and calices will be possible. Already several products have been announced which promise to be better than the present medium. It is said that uroselectan has been improved and that many of its deficiencies have been largely obviated. Similar claims are being made for a product which is about to be placed on the market, called "skiodan." My limited experience with the latter substance would lead me to believe that most of these claims are substantiated and that it is a definite improvement over earlier mediums. Among the several advantages may be mentioned earlier excretion, absence of subjective reaction to its administration, and increased clarity of the resulting urograms. It is to be hoped that progress in this field will continue and that the ideal medium will soon be available.

CONCLUSIONS

1. Intravenous urography offers a valuable addition to means of diagnosis of diseases of the urinary tract.

2. It makes available a method which sometimes permits of diagnosis without the necessity of obtaining cystoscopic data.

Fig. 10. Retrograde urogram: unilateral fused kidney with no evidence of pyelectasis.

Fig. 11. Intravenous urogram: upper pelvis shows evidence of pyelectasis; lower pelvis not outlined.

3. Its universal use will be limited because knowledge of urographic interpretation is necessary and because cystoscopic and other clinical data are usually necessary before exact diagnosis can be made.

4. The greatest value of intravenous urography to the urologist will be its employment in cases in which cystoscopy and ureteral catheterization are contraindicated or impossible. It will be particularly valuable in children.

5. With the present medium the films are still frequently too inexact for interpretation.

6. The greatest weakness of the method lies in its failure to accurately outline minor deformities.

7. Its value will be greatest in the presence of urinary stasis.

8. Failure of renal visualization does not necessarily indicate that renal function has been destroyed.

9. It is frequently of value as a visual functional test and often will suffice to determine the presence of a good kidney on the opposite side from that to which symptoms are referred.

10. Mediums which contain organically combined iodine offer ideal solutions for use in retrograde pyelography.

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DISCUSSION

DR. LEOPOLD JACHES, New York City. It is always a pleasure to hear Dr. Braasch discuss conditions of the urinary tract, particularly urography. I agree with him that interpretation plays a very great part in the intravenous method; but so it does in the retrograde. I have, in an experience of nearly twenty years, seen obviously faulty interpretations of urograms obtained by the cystoscopic method, and will undoubtedly during the next ten years or so meet with many faulty or erroneous interpretations of roentgenograms obtained with the intravenous method.

With regard to the reactions, I would say in approximately 150 cases we have had only two, as far as I can remember, where patients complained of pain in the arm and in practically none did they complain of very severe headaches or fatigue. The headaches we were able to overcome, or at least to palliate, by putting a cold, wet towel on the patient's forehead.

I also agree with Dr. Braasch that intravenous urography is not a method that would supplant the retrograde one. As I have said before on several occasions, it will supplement but not supplant it. I recommend, however, that when both methods are used the intravenous should precede the retrograde because it has been our experience that the kidney which has been subjected to the older method has for a week or even longer apparently ceased to function, at least it was not visualized intravenously after the retrograde method had preceded it.

Of course, we shall have to learn to interpret what the dim outlines in the intravenous method mean, but we have at least the consolation that these outlines are not due to the faulty injection technique of the cystoscopist.

Where you have at your disposal such a staff as exists at the Mayo Clinic and in the best hospitals, you do not meet this difficulty, but I have seen many cases in which the injection was so poorly done that no interpretation could be made.

I would like to know whether Dr. Braasch has noticed that in the patients perhaps above sixty, the kidney function is so poor that the intravenous method is of practically no value. The excretion of the uroselectan is so slow that at no time do you get a really good outline of the pelvis or ureter; the only organ that is well outlined in those cases is the bladder.

With regard to hydronephrosis, particularly in the congenital cases, we have noticed that the enlarged calices will fill up much earlier than the renal pelvis. Quite frequently the calices, unless they are obstructed, will be emptied by the time the renal pelvis is completely filled.

We also noticed that in cases of renal or ureteral calculus, the intravenous urogram on that side did not give the information that we desired. Whether that was due to spasm of the ureter or of the renal pelvis or of both, I do not know. But just as we have in cases of obstruction by the calculus been able to show very well the renal pelvis and the part of the ureter above the obstructing calculus, we have in other cases where there was no complete obstruction due to the calculus, found defective calices and pelves and an arrest of the opaque material an inch or more above the offending calculus. I do agree with Dr. Braasch that so far the diagnosis of renal tumor and renal tuberculosis has not been quite so exact as it is with the retrograde method but, on the other hand, I believe that with the observation of many more cases

we will probably arrive at a better interpretation of these findings, too.

I do not remember whether Dr. Braasch mentioned the fact that a much denser kidney outline is generally obtained by the ordinary roentgen examination. In one particular case of renal tumor, the outline of the tumor which had not much encroached upon the calices, was much better shown on the roentgenogram after the intravenous injection than before that procedure.

The chief value of intravenous urography, I believe, rests in the fact that in the future we shall be able to study renal function; of course, not alone through it, but in conjunction with the other methods that have been developed so far.

The question of faint shadows, we believe we have solved by using larger quantities of the substance for our injections. We use 60 grams for adults, and for the younger less in proportion. We still take at least four plates after the injection, the first, fifteen minutes after the last injection, then twenty-five minutes later, then twenty minutes, then twenty-five after that, and then two hours later. We found it necessary to keep the patient on the table during the first hour. For part of the time we keep on the compression bag which seems to us to have given us slightly better results.

Of course, the question of expense is a very great item in the use of this method. It is not only the larger number of films that one has to use but also the enormous cost of this particular material. I do hope that we will obtain soon a much less expensive article.

Dr. Karl Kornblum, Philadelphia. We were fortunate at the University of Pennsylvania to be one of the clinics selected for a trial use of uroselectan before this drug was placed upon the market for general distribution. We have now been using it for the past six or eight months and in that time we have had a series of about 90 cases. While I realize it is too small a number from which to draw any definite conclusions, I still feel that we have derived certain impressions which might be of benefit to those who have not yet started to use this new diagnostic procedure.

After Dr. Braasch's most excellent and complete presentation of this subject, I feel that there is little left to be added to what he has said. There are a few points, however, which I would like to make and which I would like to emphasize. We have also gone through the various vicissitudes that he has mentioned in attempting to get better visualization of the pelvis and ureter. We have used the Trendelenburg position, the compression bag, increasing the intravesical tension, but we have abandoned all of these methods and now our technique is simply that ordinarily used in the routine examination of the urinary tract. We do not feel that any of these accessories gave us any better results.

As every roentgenologist fully appreciates, one of the great obstacles to good and technically satisfactory films in urography is the disturbance caused by intestinal contents and gas. These may make valueless an otherwise perfectly good examination. In order to obviate this disturbance, we have experimented with various methods of clearing out the intestinal tract, and we have finally come to the conclusion that the use of castor oil the evening before, an ounce and a half for adults, followed in the morning by a soap suds enema where the oil has not been effectual, has given us the best results for eradicating intestinal gas.

We have also made it a routine practice to fluoroscope every patient prior to the injection of uroselectan. If we find much intestinal gas present, we do not examine the patient that day, but make further attempts to secure good elimination from the intestinal tract and do the injection the following day if the patient is satisfactorily prepared. That has saved us in a number of instances from wasting the dye at a time when our supply was limited and, of course, now that the dye is quite expensive, it is also a good economic procedure.

I have heard a number of speakers on this subject during the past few months, including Dr. von Lichtenberg, who appeared before the American Urological Association in New York in June, and I have always felt with regret that they have paid so little attention to showing us their poor results, rather than showing us all their best results, because in our early experience we obtained very poor results in securing adequate filling of the pelvis and ureters. I feel that is going to be the experience of most of you who will use this method, and such results will be disappointing and discouraging. Yet if you will realize that all who are using this method today have gone through the same experience, it will help at least to give you confidence in the future of this procedure.

We have come to regard a urinary tract not completely filled as probably normal or negative. That does not mean, of course, if there is no visualization at any time. This would indicate an absence of function. We have also come to regard a complete filling of the pelvis and ureter, even though it is without any appreciable dilatation, as an indication of some form of partial obstruction.

I think that covers the chief points that Dr. Braasch has not already mentioned. I also agree with him that this is not going to supplant retrograde urography. There is no question that intravenous urography is much more difficult of interpretation than retrograde urography, because you are not only dealing with anatomic and important morphological changes, but you are dealing at the same time with the active physiology of the urinary tract which will call for interpretation as well as the morphologic changes present.

I believe, however, that there is a danger to be encountered in this procedure and that is in its possible use by everyone who happens to own an x-ray outfit. I feel that this is strictly a procedure for the urologist to supervise in conjunction with the roentgenologist.

At the University of Pennsylvania, we examine only patients by this method who have been referred to us through the urological department. I feel that if you are going to attempt to interpret intravenous urograms without an adequate knowledge of the urinary tract, you are probably going to do your patients more harm than good.

DR. WILLIS F. MANGES, Philadelphia. I want to add my personal tribute of appreciation to this very excellent paper and to emphasize just one point that Dr. Braasch has made. He showed you in one of his slides that after the intravenous method there was no pelvic or ureteral shadow on one side but evidence of pathology on the other, and he made the remark that that did not indicate functionless kidney. I want to emphasize that point, that this is true. If you have tried any considerable number of injections of the urinary tract under the fluoroscope, you must have seen how quickly the normal kidney pelvis is capable of emptying. It may fill up and empty just as promptly as I close my hand. There are times when the kidney pelvis will not relax and take up the solution even under the influence of normal injection. It is in cases that have normal pelvic outline. The diseased pelvis never refuses to take the solutions that are injected. I am making these remarks to emphasize the point that if you are using uroselectan, no pelvic or ureteral shadow is not interpretable in terms of pathology.

DR. BRAASCH (closing). I agree with the observations made in regard to the value of the intravenous urogram, and also that it will not take the place of cystoscopy and retrograde urography. Although intravenous urography alone will suffice in some cases, it will usually be necessary to have additional cystoscopic data to arrive at a complete diagnosis. Some of the symptoms accompanying injection of uroselectan were described. I should add that in most patients the reaction was slight and in only a few was it severe. Moreover, these symptoms will soon be a matter of historical interest, since newer media such as skiodan have already eliminated them.

Diminished renal excretion is probably a large factor in the dim visualization of the kidney pelvis which is often observed. This occurs in some cases even though the usual functional tests would indicate normal renal function. When the tests indicate poor function, I would suggest that the films be delayed for a long time after injection.

I wish to thank Dr. Kornblum for his discussion, and I agree with him that many of the urograms are too dim for exact interpretation. I tried to keep this dark, however, for fear of condemning the method. A medium recently advanced, skiodan by name, has visualized the renal pelvis more distinctly, at least in the few cases in which I have tried it.

I agree with Dr. Manges in his remarks. I wish to repeat that uroselectan in 40 per cent solution is the best medium for pyeloscopy. It is much better than 30 or 40 per cent sodium iodide, which has been employed for this purpose in the past, because it is not irritating. The convulsive, spasmodic persistalsis observed with sodium iodide is greatly reduced and the ureter can be visualized much more satisfactorily.

In closing, let me heartily thank you for this opportunity to appear before you. I am sure that intravenous urography will be the means of bringing the urologist and the roentgenologist in closer contact, not in a spirit of competition, but in a spirit of mutual cooperation.

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THE VALUE OF THE ROENTGENOLOGIC EXAMINATION IN PULMONARY TUBERCULOSIS*

By HOMER L. SAMPSON *and* LAWRASON BROWN

TRUDEAU, NEW YORK

IT REQUIRES some temerity for us to appear before you to discuss any subject dealing with roentgen rays. However, the experience of any honest men is helpful, even if it proves no more than that they are poor observers, illogical and trivial. We trust that what we wish to present to you today will not fall into any of these classes. At the Trudeau roentgen laboratory, during the last seventeen years, some 50,000 stereoscopic plates and films of the lungs have been taken. Since the introduction of the method of taking films on admission and discharge, and often at other times, was begun, almost 4000 patients have passed through the institution, involving the taking of some 15,000 films. Practically all of these are now on file and most of them have been used in various clinical and statistical studies which from time to time have been made. Besides these, a very large number of private patients from Saranac Lake and the surrounding district have also been studied. It is but natural to conclude that some very definite opinions of the usefulness of the roentgenogram in the study of pulmonary tuberculosis have gradually presented themselves to our minds. This evaluation we wish to lay before you as briefly as possible. We have found the roentgen examination of great value in some of the complications of pulmonary tuberculosis, which we shall mention in passing.

From the many phases of the subject which have beguiled us, we have selected a few to present to you. These include data concerned with the early appearance of roentgen shadows in the lung fields, the extent of the lesions, the character of the disease, its evolution, its healing, the value of the roentgen examination in the complications of pulmonary tuberculosis, and finally its great importance in the diagnosis of tuberculosis in infants and children.

THE EARLY ROENTGEN MANIFESTATIONS OF PULMONARY TUBERCULOSIS

There are two questions that recur perenially:

A. Do changes on the film precede those detected by the usual methods of physical examination? In the first place, we believe that the time has come when we must insist that no patient has been completely examined until his film has been carefully gone over. For this reason we now say that the physical examination must consist of the following procedures: inspection, palpation, percussion, auscultation and the roentgen examination—five, instead of the usual four procedures. In answer to the first question, we think we can catagorically say that in a surprisingly large number of cases, definite changes characteristic of tuberculosis occur in the film long before definite evidence of abnormal physical signs can be detected. We believe that changes on lung films in reference to tuberculosis may be referred to as negative, doubtful, suggestive, characteristic, but never as pathognomonic. While all the data that can be obtained from the film such as age, sex, location, character of the shadow, etc., must be drawn upon in diagnosis, nevertheless we are always very suspicious of moderately coarse and fine mottling, irregularly distributed in any portion of the lung. We realize very clearly that tuberculosis can produce changes other than such mottling, which in many cases is difficult, if not impossible, to differentiate from that due to other conditions. However, when such mottling does occur in the upper third of the chest, we maintain that it is character-

* Read at the Thirty-first Annual Meeting, American Roentgen Ray Society, West Baden, Ind., Sept. 23–26, 1930.

istic of tuberculosis, which must always be kept in mind until disproved, even when the physical signs are normal. It is of interest to note that among 1367 consecutive cases at Trudeau, 32 per cent had either such slight or indeed no abnormal physical signs that diagnosis was established entirely or in large part, from the study of the film. Among the last 1004 cases seen in private practice in Saranac Lake, 148, or 15 per cent, of such cases occurred.

B. How early in the course of the disease can definite changes be detected? This question has long interested us, for although some have stated it to be so, we could not conceive from the experiments performed in the laboratory, how a cubic centimeter of caseous material occurring in the lung field, could escape detection on a well taken film. This is of course very different from detecting the earliest changes in pulmonary tuberculosis, which we are forced to recognize may escape recognition, on account of their location or on account of their slight density. As far as we can determine, however, such changes, or rather lack of changes, are unusual for in only 1 or 2 per cent, or indeed less, are parenchymatous changes lacking in cases where tubercle bacilli occur in the sputum. In the last 500 patients, no such case occurred. The relation of the time the patient comes to the roentgen laboratory in regard to the time of onset of the disease, varies greatly. It is apparently directly related to the location of the focus in relation to the pleura or to the wall of the bronchus, for probably only when this is attacked do localizing symptoms arise. In most cases the discovery of abnormal physical signs, perchance by accident, leads to the film. In a certain number of instances, now increasing in number, routine examinations are supplemented by the study of films. We think that we might be able to defend a thesis which would state that any patient who presents only peritruncal, or indeed no changes upon the roentgenogram at the age of twenty-five, has very slight chances of developing active pulmonary tuberculosis later in life. The routine examination of large numbers of school children leads us to believe that definite roentgenologic evidence of pulmonary tuberculosis exists in many cases for years before symptoms arise that focus attention upon the lungs; and symptoms, as is well known, often precede the appearance of abnormal physical signs.

In an attempt to determine how soon tubercles appear upon the film, we have studied roentgenologically, miliary tuberculosis in rabbits, and have seen definite tubercles on the films thirteen days after inoculation. When the lungs were removed from the thorax and inflated to the normal size, the tubercles stood out very clearly. In many, if not in most instances, however, the first manifestations discovered in the lung roentgenograms after puberty are accompanied by considerable collateral inflammation due to the fact that the individual is more or less allergic. The deposit in the lungs of a few scattered tubercle bacilli leads, we believe, to scattered mottling of slight extent. If numerous tubercle bacilli are deposited, we may have miliary pulmonary tuberculosis. The usual thing, however, is a condition between these extremes, one which may lead to infiltration, mottling in the upper third of the lung, or to a more intense exudative focus in the same area, the so-called subclavicular infiltration. This type of infiltration is usually diagnosed only from the film and the sputum. In an occasional patient it has been noted that lesions have been discovered on the film where a week or ten days previously they did not exist. In one instance a focus manifested itself within forty-eight hours. Such exudative lesions would be more commonly discovered were films taken more frequently at shorter intervals.

Such facts as these have focused attention upon the differences in tissue density and volume, though it is true that other factors play an important part in the detection of disease. Not until certain density valuations exist can we expect to show shadow differentiations or be certain that pathological deposits or infiltration are de-

veloping in the lung. Certain experiments along these lines we hoped would help to throw some light on how soon we can expect the film to register disease in the lung. Accordingly an attempt was made to standardize tuberculous tissue in terms of some other substances that might have a comparable shadow-producing value for the same weight and thickness. By altering the spark gap or penetration, it is possible to produce entirely different results in shadow values when measured by the Benoist penetrometer, with its graduated steps in thickness of aluminum. Again the results obtained by the direct method and by the use of the intensifying screen are not the same, even when the other factors are kept constant.

For instance, 2 mm. of aluminum has about the same shadow-producing value as 5 mm. of fibrocaseous tuberculous gland tissue, whereas a thickness of about 4 mm. of caseous tuberculosis cut from the lung of a guinea pig is equal to about 1.5 mm. of aluminum. But here the thickness of the aluminum is considerably less than that of the tuberculous tissue. Evaluating the tuberculous tissue in terms of a penetrometer made of cardboard, one finds that about equal thicknesses of tuberculous tissue and cardboard cast about the same shadow. From this we can safely infer that we can evaluate this particular tuberculous tissue in terms of a substance such as the cardboard* used. Therefore in experiments, given the thickness of the tuberculous tissue, it is possible to replace it with cardboard which has the same shadow-producing properties. So having determined that 4 mm. of cardboard had the same shadow-producing property as 4 mm. of tuberculous tissue, the cardboard "equivalent" was roentgen rayed under various conditions, using different roentgen factors to determine what effect voltage, milliamperage, distance, time and screens might have on the ultimate results. The "equivalent" was placed in a metal box 10 cm. in diameter and 7.5 cm. deep, the wall of which was 1.5 mm. thick. Using a variety of roentgen techniques, it was possible to record the shadow of the "equivalent" in all the experiments performed. This proved that the metal wall (top and bottom) of the box was not sufficient to prevent the "equivalent" from registering a shadow. In this experiment it is obvious that a sufficiently long time of exposure, necessary to penetrate the metal container, was used. In the above experiment the container had density, but not volume. It was necessary then to roentgen ray the "equivalent" in a container that had volume and was of a moderate density, something that would be comparable to that of the chest wall. For this purpose a spherical paraffin mold, 6 inches in diameter, having in the center a spherical space about 3 inches in diameter, was used. This would make the wall about 1.5 inches thick.

Using approximately the same technique as that used for the human chest, with the exception of the time of exposure, we were able to demonstrate clearly both in the stereoscopic and single films, the definite shadow cast by the "equivalent." If, however, the central spheroidal space was steadily reduced in size, a point could be reached where the shadow produced by the "equivalent" was not demonstrable, indicating that the shadow-producing value of an object is influenced materially by the space in which it is placed, as well as by the relative density and volume of the container.

Subsequent experiments were performed in which a cubic centimeter of tuberculous tissue, cut from a guinea pig's lung, was placed on the front and back of the chest of a healthy man. Stereoscopic films were then made in both the posteroanterior and anteroposterior positions, with the tissue at one time nearer to the film and at the other time farther from the film. Under the latter condition the diseased tissue was 8 inches from the film. With the tube at a film distance of 3 feet, it was possible to demonstrate clearly a shadow cast by the cubic centimeter of the caseous tuberculous

* The cardboard used is that which commonly comes packed with Eastman films.

tissue. If the shadow of the rib superimposed, the shadow of the tuberculous tissue was very indistinctly seen, but was nevertheless visible. This also demonstrated the value of stereoroentgenograms, for whereas in one film a definite shadow was seen, in the other it was partially obscured by a rib.

Having then reasonably established that small areas of disease are demonstrable on good stereograms, it was obviously necessary to attempt to standardize the impressions as to the character of the shadows seen in pulmonary tuberculosis. At the outset there are certain important points to be borne in mind. First and most significant is that a final diagnosis should not be made until all data are collected or until sufficient evidence is available. Secondly, pulmonary disease is characterized by differences in densities on the film or screen, and with the fluoroscope, pathological changes may manifest themselves by variations in movement of certain organs. Again there may be changes in outline of the parts under consideration. However, the most important of these variations is the change in tissue density.

To say that there are pathognomonic shadows of pulmonary tuberculosis would be an error, for undoubtedly other pulmonary diseases do present shadow complexes that are very similar. However, everyone employs well-worn statements to the effect that "this looks like tuberculosis," referring to a mottling confined to the upper half of the lung field, or "that is a neoplasm," referring to the heavy shadows in the root or mediastinal regions. In other words, while it is inadvisable to assume that tuberculosis, or any other pulmonary disease has pathognomonic shadows, familiarity has taught us to make certain differentiations which are reliable. Film interpretation will always remain a matter of personal equation or judgment, and a final diagnosis—to be arrived at only after the correlation of all data present—has also been, and will continue to be, empirical, even though accepted standards or criteria bespeak a certain disease. However, there will apparently always be a few instances where all signs fail. Mottling, familiar to everyone, when found above the hilum of the lung, will be found to be due to tuberculosis more often than otherwise. When associated with circumscribed areas of rarefaction or annular shadows, or with the string-like shadows of fibrosis, the diagnosis of pulmonary tuberculosis is further strengthened. The same shadow complexes found elsewhere in the lung, with the apices free, lessen the probability of tuberculosis. Nevertheless, characteristic mottling at the base has often been proved to be due to tuberculosis.

The incidence of the five cardinal diagnostic data in 1367 cases diagnosed pulmonary tuberculosis from 1478 consecutive cases in the Trudeau Sanatorium are as follows:

	per cent
Tubercle bacilli	61.5
Râles	68.5
Roentgen ray	99+
Hemoptysis	33.5
Pleurisy	12.0

Having established a diagnosis of pulmonary tuberculosis, the roentgen examination now assumes a new rôle: that of registering the changes that may take place in the existing foci or in the development of new areas of disease. In other words, the film now enters the field of treatment or prognosis. In the minds of many phthisiologists, particularly those in sanatorium work, it is conceded that the serial film is probably the most reliable method of following the course of the disease. From this it is not to be inferred that stereoscopic films are capable of registering the finer macroscopic changes that take place, but that they are rather looked upon as a means of adding material information not otherwise obtainable.

Often a progressing lesion is revealed days before symptoms manifest themselves (Figs. 1, 2 and 3) and as is well known, symptoms, or an increase of symptoms due to a relapse in pulmonary tuberculosis, may

precede by two weeks changes in the physical signs. In fact, the symptoms may have largely or entirely abated when the increase of abnormal physical signs is discoverable. At Trudeau no patients who have pulmonary cavities detectable by physical signs are admitted and yet 30 per cent of all patients admitted have cavities revealed by the roentgenograms. The detection of the development of cavities, so important in the treatment, depends practically entirely upon the revelations of the roentgenogram and indeed the detection of small and even large cavities is often determined only by the same method.

Fig. 1. Mr. R. D., right lung: small area of infiltration (infraclavicular). Residue of a previously more extensive disease. Patient now working; no symptoms.

EXTENT OF THE LESION

While there are certain limitations to be recognized, the roentgenogram can usually be relied upon to register the extent of the lesion, frequently revealing more disease than is detectable otherwise, and in many instances bringing to light foci which would otherwise be overlooked. Occasionally, however, the reverse is true and the presence of physical signs occurs where no disease is seen on the films. However, this occurs more often in connection with nontuberculous than with tuberculous conditions in the lung.

It must be constantly borne in mind, however, that the recognition of pulmonary foci will depend upon the extent and location. From experiments performed on animals (rabbits), it has been demonstrated that tubercles not much larger than a

Fig. 2. Mr. R. D. Six weeks later. Patient appears a little "peaked"; no other significant symptoms. Roentgenogram reveals a reaction at the site of the lesion with questionable cavity formation. Patient put to bed on strength of the increase.

millimeter could be clearly demonstrated in the excised lung. These foci were about fifteen days old. In other experiments on guinea pigs, it has been possible to see small areas of disease in the living animal, which were later confirmed at autopsy.

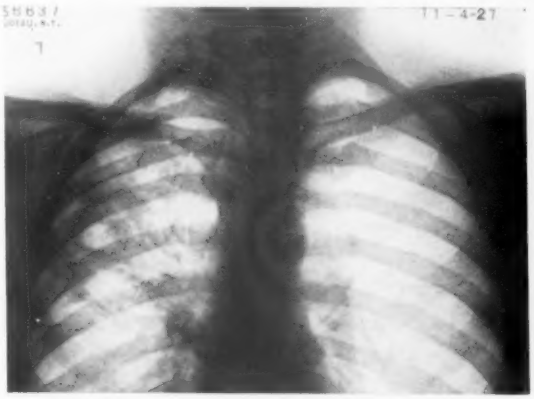

Fig. 3. Mr. R. D. One month later. Manifest symptoms now present; hemoptysis. Roentgenogram shows definite extension of the disease with definite cavity formation. Later artificial pneumothorax and arrest of disease. Patient working. This series of films, as with many other patients, emphasizes the value of serial roentgen examination.

In order that we might approximate conditions met with in the human, an experiment previously referred to was performed. A small mass of tuberculous tissue was excised from an animal's lung and suspended on the chest of a normal man. No matter where the tissue was placed in the pulmonary field, it was clearly demonstrable in the stereoroentgenograms, even though at times its shadow was superimposed upon that of a rib. It was also seen when placed farthest from the film, *e.g.*, on the patient's back.

From this it could be deduced that less than a cubic centimeter of tuberculous tissue will register a shadow if placed in the pulmonary field of an aerated lung. Experiments of this character have been recorded in the past by other observers with opposite results; which raises the question, "Was there sufficient opportunity for the diseased tissue to record its shadows?"

It has long been deemed important to classify the cases of pulmonary tuberculosis into groups or, as it is more commonly termed, stages. It will be recalled that for years symptoms and physical signs were used as the basis for such divisions. Some fifteen years ago a committee of the American Sanatorium Association, one of the many committees appointed for this purpose, recommended that inasmuch as symptoms left too much to the personal equation of the classifier, they be omitted, and that all patients should be classified according to the inferences from the physical signs. One of us (L.B.) objected on the grounds that such a classification would be far more inaccurate than one in which both physical signs and symptoms were used. He presented a minority report in which he urged the use of the roentgen ray, which was voted down. Since that time many reports have shown how much more accurate is the roentgenogram in revealing the extent and intensity of the disease. It is of great interest to record that finally, last Spring, the Committee on Standards of the National Tuberculosis Association determined that it was now advisable to classify entirely upon the extent and intensity of the disease as revealed by a study of the roentgenogram. With this in mind, we have reclassified 1472 cases at the Trudeau Sanatorium and the very interesting results are shown in Table I.

TABLE I

RECLASSIFICATION OF 1472 CASES

73 non-tuberculous	120 suspects		392 minimal		809 moderately advanced		78 far advanced	
		per cent		per cent		per cent		per cent
Remained the same	N.T. 85	71.0	N.T. 98	26	N.T. 26	3.0		
	Sus. 18	14.9	Sus. 43	11	Sus. 20	2.5		
	Min. 16	13.3	Min. 134	33	Min. 123	15.0		
	M.A. 1	0.8	M.A. 109	28	M.A. 621	77.0	M.A. 15	20
			F.A. 8	2	F.A. 19	2.5	F.A. 63	80

It is of some interest to note briefly the changes when the classification was based mainly upon the roentgenogram. Of the "suspects" of the original classification, only 15 per cent remained in this group, while 71 per cent were transferred to the "nontuberculous" and 13 per cent to the minimals. Of the "minimals" 33 per cent remained in the group, 26 per cent were transferred to the "nontuberculous," 11 per cent to the "suspected" and 28 per cent to the "far advanced." The "moderately advanced" group was least affected but 20 per cent of the "far advanced" were transferred to the "moderately advanced."

CHARACTER OF THE DISEASE

Attempts have been made to classify the pulmonary disease as to type, having at the extremes the acute exudative tuberculous

bronchopneumonia, and the old healed fibrous "scar" or calcified nodules. In any attempt to do this many difficulties are encountered. First, in the usual sanatorium patient, complex conditions exist, *i.e.*, small areas of acute exudative disease superimpose themselves upon a more or less proliferative or productive type, and during this phase, cavity formation may develop. Then one would have to consider a proliferative-exudative-cavernous tuberculosis. Probably the most satisfactory way out of such a dilemma would be to classify on the predominant type, with reference to the presence of a cavity if it existed. Nevertheless, in the estimation of many qualified roentgenologists, it is incumbent on the roentgen laboratory to attempt such a classification and offer numerous explanations.

It is not within the scope of this paper to discuss the pathology of tuberculosis, nor is it within the province of the roentgenogram to do more than evolve a simple terminology that might be applied to the different types of lesions seen. The finer anatomical pathological differences will remain for the pathologist to determine. The following terms when applied to data obtained from the films of a case of pulmonary tuberculosis appear to have a practical application and one that embodies terms that are readily evaluated: fibrous or calcific, productive or proliferative, caseous, exudative, cavernous (when essentially only cavity exists), miliary (not necessarily implying hemogenic metastasis).

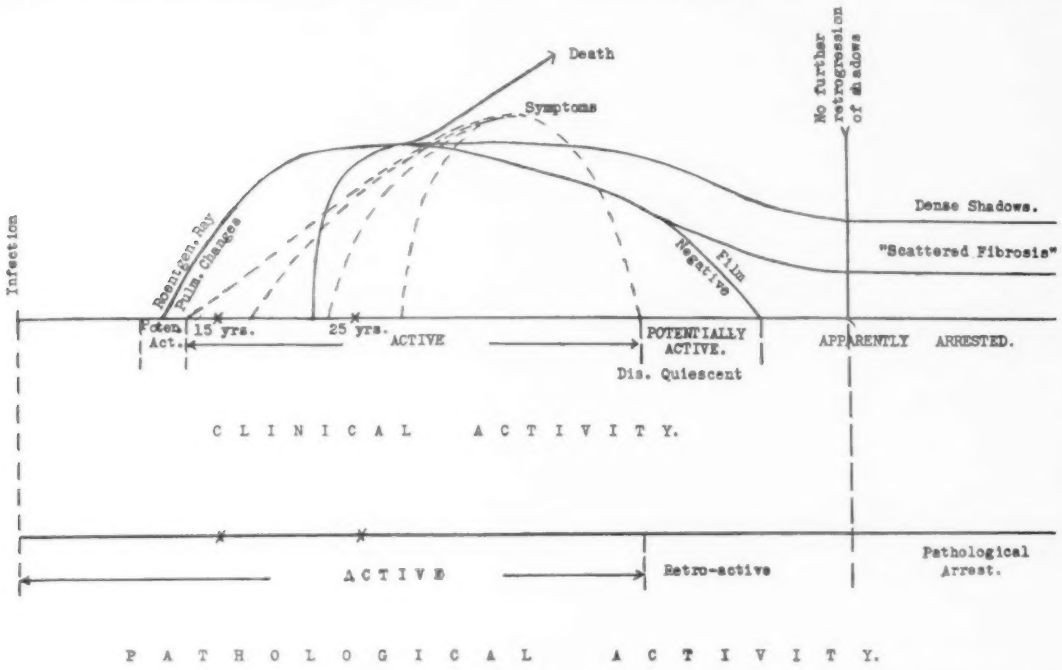

FIG. 4. Schematic diagram showing relationship of roentgenograms to clinical and pathological activity.

Combinations of any of these terms are possible, and in fact the various types of disease occur, as stated above, often in combination.

EVOLUTION OF THE DISEASE

As has already been stated, the stereoscopic film offers the most reliable method of recording the progression or retrogression of the pulmonary disease. It is also a reasonably reliable means of determining the activity of a process. However, from this, it is not to be inferred that in any specific case can one be absolutely certain in regard to the presence of activity. Con-

siderable disagreement exists regarding the value of the roentgenogram in this respect. Some believe that the disease can progress or retrogress, and not necessarily be seen on the roentgenogram. In a series of cases studied, it was found that the stereoscopic films conveyed valuable information regarding the status of the disease, often bringing to light evidence of activity which otherwise was not suspected. In regard to this point, several factors have to be borne in mind. First, where many shadows (extensive disease) are present, it can readily be understood why small and yet definite changes may take place and pass unrecognized. In this connection, however, it is a question whether such small changes have any apparent effect on the patients' symptoms and if such be the case, would they not go undiscovered unless some other method of investigation or examination brought them to light? Secondly, it is not uncommon to note increases appearing in the film, interpreted (1) as new disease or (2) as reactivation of previously existing foci, when there is no increase of symptoms to correlate with this finding. These new areas or increases in the previously existing shadows have usually characteristic borders. Commonly they are very ill defined, and the extreme margins do not as a rule have any hint at demarcation. As most shadows grow older, they usually become denser in the central field, and the margins become clear cut, and in fact reveal abrupt differences in density as compared with the surrounding lung field. Older shadows appear less confluent, like tapioca drying out. With serial roentgenograms and a good revolving stereoscope with which it is possible to compare very exactly minute and corresponding areas on the serial films, the determination is easy, but it is another thing to attempt to do this from a single set of films, and yet it can be done with a fair degree of accuracy after practice.

In a study of 373 cases at the Trudeau Sanatorium, an attempt was made to compare the relative value of determining the presence of activity on admission to the institution by clinical means and by the roentgenogram. The problem was a difficult one and it was deemed best to evaluate the results by comparing the course of the disease while in the institution. The clinical activity was based on a study of the patient during the first week in the sanatorium and "roentgenologic" activity on stereoscopic films taken during the week by one of us (H. L. S.). The figures given in Table II speak for themselves. When the disease was "clinically inactive" 37 per cent showed no change but 17+ per cent grew worse, while 48 per cent of the "roentgenologically inactive" showed no change and only 6 per cent an increase. When the disease was "clinically active" 15 per cent showed no change and 53 per cent grew worse, while for the "roentgenologically active" the figures were 3 per cent and 62 per cent respectively. Such striking differences need no comment.

TABLE II

COMPARISON OF BEHAVIOR OF DISEASE IN PATIENTS DIAGNOSED ACTIVE AND INACTIVE BY CLINICAL METHODS AND FROM A SINGLE SET OF STEREOSCOPIC FILMS

			Static	Decrease	Increase
Clinically	Active	95	14–15%	30–32%	51–53%
	Inactive	278	102–36.6%	127–45+%	49–17+%
X-ray	Active	140	4– 3%	50–35.5%	86–62%
	Inactive	233	112–48%	107–46%	14– 6%

The better the roentgenograms and the more perfect the stereoscopic effect, the easier it will be to pick out these differences. Films of a low grade or of an indifferent character with any blur, will be of little value in such instances, and it becomes apparent that much devolves upon the roentgen laboratory to produce a roentgenogram

that will be less misleading than otherwise. It is difficult in our experience to arrest motion on films exposed more than 1/15 or 1/20 of a second.

The familiar so-called "end-result shadows" are ordinarily the product of organization of the foci. With serial roentgenograms taken over long periods of time, much information is obtained regarding the evolution of such shadows, and while it may be unwise to speak of them in terms of different ages, it is nevertheless evident that different groups can be interpreted as older or more recent than others. It is to be constantly borne in mind that the final decision as to the progression or retrogression, or to the activity or inactivity of a focus, is not usually to be drawn only from the evidence as revealed in the roentgenograms, although there are instances where it is necessary to do so. Very often subsequent roentgenograms substantiate such a view.

In the treatment of pulmonary tuberculosis by artificial pneumothorax the fluoroscope and film are constantly used. Indeed today it is difficult to see how we ever did without them.

HEALED

Undoubtedly it is unwise to regard the film as revealing a healed focus, for this would imply that one can deduce from a study of the film the presence of complete encapsulation of bacilli or, in fact, the absence of viable organisms. It is now, however, possible to observe shadows that have not altered in months. These usually are well "organized," commonly more or less isolated with clear cut margins, and many times associated with stringy manifestations, which everyone knows are seen in long standing disease. With such manifestations, it is reasonably safe to assume that the disease is well cicatrized, and when such changes are associated with clinical data that bespeak the same thing, could be interpreted as indicating an arrest of the process. The time is now at hand to question whether a pulmonary tuberculous process should ever be spoken of as arrested until the serial films cease to show any change, whether for better or for worse. Certainly to do so only on clinical evidence is most untrustworthy and leads to many sad mistakes. To assume therefore, that such unchanging shadows as mentioned above are an indication of a healed lesion is, in many instances correct, but it is more scientific to state only that the disease is arrested. The day is not far off when much more reliance will be placed upon such changes or lack of changes in the pulmonary shadows.

To the axiom that "shadows do not lie" may be appended "be careful of the technique"; "do not confuse fact with inference" and "remember that more than one deduction may be made from the same set of observations."

EXTRAPULMONARY TUBERCULOSIS

The use of the roentgen ray in pulmonary tuberculosis would not be fully evaluated unless a word were said regarding its application to certain extrapulmonary tuberculous conditions, particularly involvement of the lymphatic glands and of the intestines. It is already well known (having been established by other workers) that the normal glands even in the hilum of the lung, do not cast recognizable shadows on the film. Whether this is due solely to the delicate structure of the glands or to the inability of the observer to differentiate it in such a confusion of shadows as those seen at the root, is a matter that deserves our consideration. It is a fact, however, that the normal glandular structure in the cervical, axillary, inguinal, abdominal and other regions, is not capable of registering on the film. When, however, either the density or the volume of this tissue exceeds certain limitations, which cannot very readily be defined, it is possible to get a registration on properly exposed films. It is a well-recognized fact that glands having deposits of calcium within them, cast shadows that can readily be seen. Those met with in films of the chest are most frequently

found in the cervical and axillary regions. The discovery of such densities, while having possibly no other value than that of indicating infection, may lead the observer to an otherwise obscure lesion in the chest, or may contribute valuable confirmatory evidence in a case where the pulmonary focus is in doubt.

Cervical glandular disease, characterized by the usual densities, in a somewhat chain-formation has been traced (on the film) to a definite apical disease in the lung, suggesting a direct communication with the pulmonary focus; a view which has been advanced by some phthisiologists, especially Van Zwaluwenburg.

While most of the cervical and axillary glands that are visible on the film can be palpated, there are instances where the film has been the means of bringing them to the attention of the physician, and it is not impossible for the gland to be so small and so deeply seated as to escape detection by palpation.

Research investigation recently published has demonstrated conclusively that the demonstration of the calcification of the glands within the abdomen is frequently possible by the use of the roentgen ray.

Possibly one of the most important uses of the roentgen examination in patients is in the detection of secondary ulceration of the intestines. With a properly controlled technique, using a barium meal and enema, it has been possible to demonstrate the presence of this form of disease, where under other methods of examination, it was obscure or not even suggested. The criteria upon which to base an interpretation of ulceration is that of spastic filling defects and localized and possibly generalized hypermotility. The ulcerated area undergoes a change in its physiology of movement, and barium passing into this hyperactive segment remains there at times only momentarily or possibly a few minutes at the most, and the fluoroscope or roentgenogram reveals a poorly filled segment, many times in a state of contraction or spasm. This irregularly filled area presents the so-called spastic-filling-defect, characteristic of an ulceration in the ileocecal region.

It is important that in all cases of moderately and far advanced stages of pulmonary tuberculosis intestinal tuberculosis should be excluded, and indeed also in any case with abdominal symptoms or in one not doing well.

INFANTS AND CHILDREN

Within recent years a great deal of interest has been developed in the systematic roentgen examination of children.

Probably no field of investigation offers more opportunity for satisfactory results than does the use of the film in the detection of pulmonary tuberculosis in the infant and child. With it, a diagnosis is often possible, when otherwise there would remain only vague suspicion. Most workers are unanimous in the belief that the film is the most essential factor in the examination of the child's chest and without it, pulmonary disease, particularly pulmonary tuberculosis, would for a long time remain unrecognized. In fact, after much study many pediatricians base the diagnosis of tuberculosis almost entirely upon the findings on the film and the result of the tuberculin skin test.

In many centers large numbers of children have received the benefit of this method. These investigations have been developed along different lines. Some have roentgen rayed only those children who responded positively to a tuberculin test, while others have included only those who are more than 10 per cent underweight; still others would include those who are known to have been exposed to the disease and who would probably have an infection. In our opinion all three classes should have the benefit of a roentgen examination.

For the past four years, we have systematically roentgen rayed all the school children in Saranac Lake. No discrimination was made as to which child should be examined roentgenographically for the reason that early in the work it was found that certain children, apparently above suspi-

cion, proved to have a pulmonary disease, and furthermore we wished to see how many children living with tuberculous parents or relatives, had contracted the disease. We were further anxious to know when and how the adult type of pulmonary tuberculosis developed. The present method calls for a yearly examination or oftener if indicated. In connection with the roentgen finding, note is made of the past and present symptoms the child may have had, family exposure, or any other points that might have a bearing on the diagnosis of a pulmonary disease. Pulmonary examination is made where there are any suspicious shadows on the film.

One of the first disclosures of this systematic examination was the finding of abnormal pulmonary shadows in apparently normal children. It was obvious that these shadows required careful consideration, but upon subsequent examination, some of the films revealed complete clearing of these abnormalities. To have said that these shadows indicated a pulmonary tuberculosis might have been an error; however, in a few instances from these areas, intrapulmonary nodules developed, which would strongly suggest a tuberculous focus.

A few cases of clinical tuberculosis were brought to light, which in themselves would justify the method. The finding of such a character has undoubtedly protected certain children from stresses that might have proved serious. Instances are recorded where youngsters, having abnormal shadows, have disobeyed instructions, and at a later date advanced disease was found which has added another death or chronic invalid to the already long list.

ROENTGENOLOGIC OBSERVATIONS ON THE MOVEMENT OF PLEURAL EFFUSIONS*

By LEO G. RIGLER, M.D.

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THE distribution of an effusion in the pleural cavity has long been a subject for investigation by physical diagnosticians and roentgenologists. It has always been recognized that factors other than simple gravity play an important part in the position which free fluid in the pleural cavity occupies. Coincident with this problem, and a natural sequence of it, has been the study of the movement of pleural effusions with change in position of the thorax. Most observers are agreed that the curving upper surface which fluid in the pleural cavity takes on, with its lateral portion higher than the medial, is due to a combination of hydrostatic pressure, the retractile power of the lung, and the capillarity of the pleura. The effect of these various factors has been studied in detail by Ganter,[5] but the exact part which each plays in the production of this phenomenon is not yet assured. It seems reasonable that the movement of effusions in the pleural cavity with change in position of the thorax should also be affected by these physical characteristics.

The wide differences of opinion which may be found in the literature as to whether or not pleural effusions shift in position with change in position of the patient, are significant of the difficulty of the problem and the variability of this phenomenon. Lenk[6] quotes extensively from most of the older and more recent continental authorities on physical diagnosis to indicate this marked variation of opinion. Strümpell, Sahli, Neumann and others[6] all agree that there is little or no shift in position of fluid in the pleural cavity under varying conditions. They believe this is quite definite in the inflammatory effusions but there is some doubt about the transudates. Gerhardt,[6] however, believes there is considerable movement if sufficient time is permitted to elapse. In this country, Cabot[3] and Emerson[4] are both inclined to the opinion that there is very little movement of either transudates or exudates. Norris and Landis[8] on the contrary, believe there is a distinct shift in the fluid level from the prone to the upright positions. The roentgen literature shows as wide a variety of opinions. Rieder[10] rather categorically states that fluid in the pleural cavity without pneumothorax never moves to any degree. Assmann[1] is somewhat doubtful but is inclined to believe the movement is slight. Brauer,[6] on the other hand, tries to demonstrate that there is considerable shifting. Wessler and Jaches[14] state that movement occurs but that it is slow and rather difficult to demonstrate, while Sante[12] was formerly of the opinion that there is comparatively little movement. In the more recent literature Bigler[2] says: "In no case of simple effusion was it possible to demonstrate a change in the level of the fluid by change in position of the patient." He was dealing with both transudates and exudates in children. Stewart[13] found no change in the position of purulent effusions in children even if the patient was completely inverted. Lenk made a roentgenoscopic study of 17 cases of inflammatory pleural effusion in the upright and prone positions and found a marked change in the level of the fluid in all but two. He believes absence of movement indicates the formation of adhesions. Merlo Gomez and Heidenreich,[7] and Polgár[9] derived the same findings in a fairly extensive roentgenographic study.

The variability of these opinions indicates how far this problem has been from solution while the importance of its accurate determination lies in the numerous diagnostic aids which the presence or absence

* From the Department of Roentgenology of the University of Minnesota and the University Hospital, Minneapolis, Minn. Read at the Thirty-first Annual Meeting, American Roentgen Ray Society, West Baden, Ind., Sept. 23–26, 1930.

of shifting of the fluid level may present. It is obvious at once that a division must be made between inflammatory and non-inflammatory fluids, between purulent and non-purulent exudates, and between old and recent accumulations of fluid. It seems possible that the differences in behavior of different pleural fluids might be accountable to their own difference in character, to differences in the character of the pleura, or to differences in the condition of the underlying lung.

In an attempt to throw more light upon this phenomenon, a roentgenographic study of a series of cases of pleural effusion was undertaken. Roentgenograms of the chest were made in the usual manner except that five, and in a few instances, six, positions were used. These were upright, prone, supine, inverted, right lateral decubitus, and left lateral decubitus. In the latter two positions the patient lies on the side, the film being in front, the tube behind. Thus, as illustrated in Figure 1, a posteroanterior exposure is made with the patient lying on one side. It should be noted that the patient is raised above the level of the table top by a cushion under the hip and shoulder. This enables the cassette, while resting on the table top, to completely cover the inferior portion of the thorax. The inferior arm is thrown upward out of the way while the superior arm embraces the cassette, helping to support it. While this position has been used previously to determine the presence of air and fluid in cases of lung abscess or hydropneumothorax, when the upright position was impossible, it has never been reported previously for the study of ordinary effusions except by Merlo Gómez and Heidenreich, Polgár, and by the author in a previous publication.[11]

The cases studied may be classified in three groups. In the first were purulent effusions, only three in number. The second group consisted of non-purulent inflammatory effusions, mostly tuberculous but with a few which were exudates of nonspecific etiology. The third and largest group consisted of transudative effusions, arising as a result of cardiac or renal failure or from mediastinal tumors producing pressure. Care was exercised to rule out pneumothorax and all cases in which this possibility

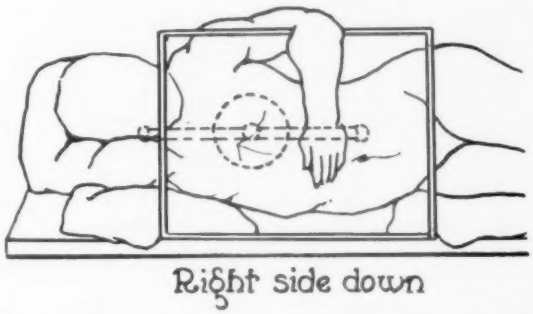

Fig. 1. Lateral decubitus position. The patient is lying on the affected side with the thorax raised from the table top by the pads under the hips and shoulders. This permits the cassette, which is in front and resting on the table top, to cover the inferior costal gutter and it is supported by the upper arm which is bent over it. The tube is behind.

existed were excluded. In most of the cases thoracentesis was used to demonstrate the true diagnosis, although post-mortem examination in a few cases and the clinical progress in the remainder were also of assistance. In addition a number of cases of pleural thickening were studied for contrast.

In the small number of cases of empyema which were examined, the conclusions of Stewart seemed to be abundantly confirmed. Very little shift in the position of the fluid could be observed even with the patient completely inverted. These findings in a case of empyema in a young child are illustrated in Figure 2. The characteristic ribbon-like shadow along the periphery of the thorax, which is so commonly seen with purulent effusions in children, is well shown in all three positions illustrated. The position of the fluid level changed little or not at all when the patient was shifted from the upright (Fig. 2A) to the prone (Fig. 2B) and, finally, to the left lateral decubitus position (Fig. 2C). Examination in the inverted position also showed no change. The explanation for this lies chiefly, no doubt, in the early formation of fibrinous adhesions, in the thickness of the exudate, and,

to a lesser degree possibly, in the rigidity of the lower lobe of the lung which fails to collapse in spite of the hydrostatic pressure applied. The number of cases of purulent cases of empyema the results obtained were the same.

In the group of non-purulent inflammatory effusions, most of which were due to

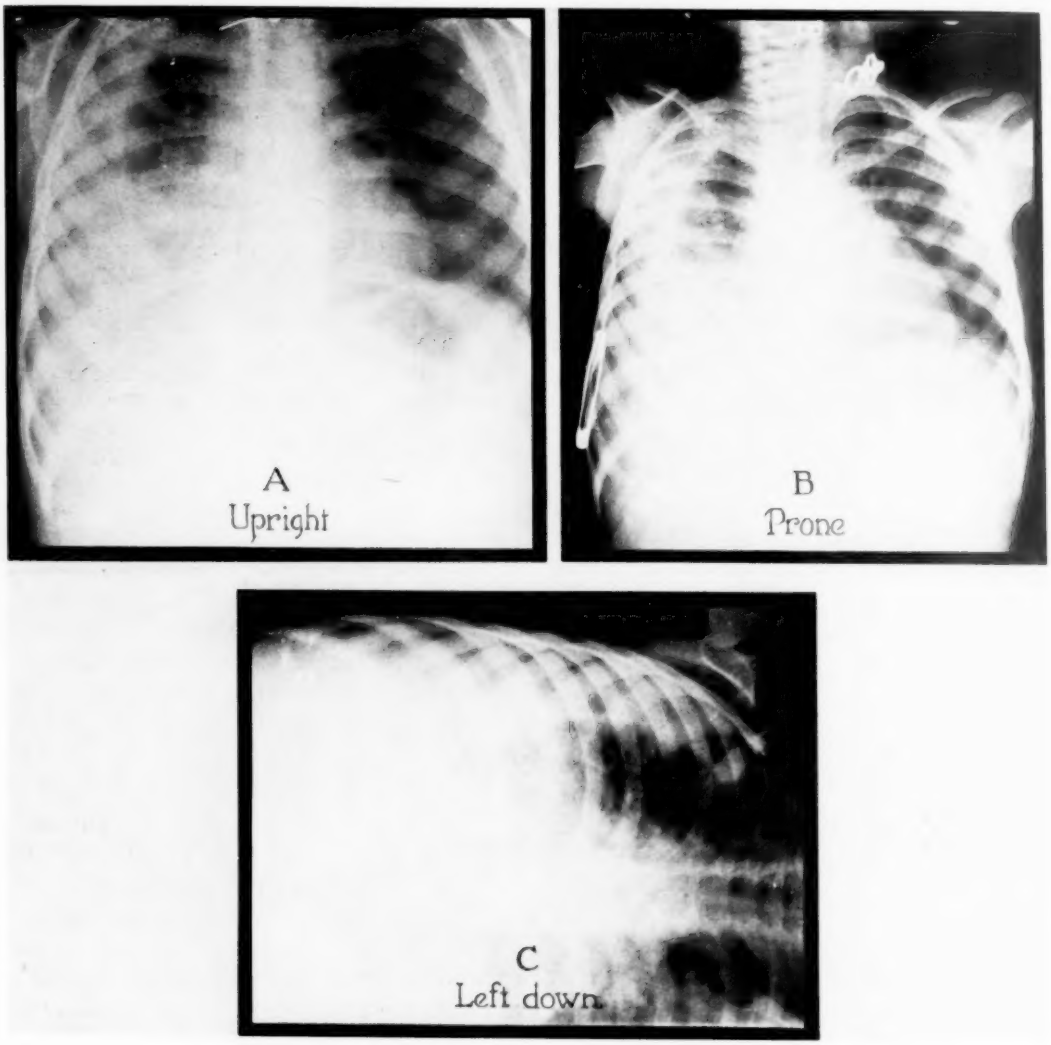

FIG. 2. Empyema in a young child. A. The characteristic ribbon-like shadow extending from the diaphragm to the apex along the periphery of the chest is shown in the upright position. B. Change to the prone position produces no change in the position of the fluid. C. The left lateral decubitus position gives practically the same findings.

effusion observed during the course of this study has been too small to give any definite conclusions. In view of the fact, however, that both Stewart and Bigler, when dealing with purulent effusions, found little or no shifting, it seems reasonable to suppose that this is the rule. In two adult tuberculosis, the findings have been quite different. In only two cases of this series have we been unable to detect any appreciable movement in the position of the effusion. One of these is illustrated in Figure 3, the characteristic fluid curve being maintained in all six positions, only four of which

are shown here. Although fluid was obtained readily by thoracentesis, the length of time during which this patient had been ill and the character of the fluid led to the hesions, which were present, explained amply the failure to obtain any movement of the exudate. These findings would therefore agree with those of Lenk that long-

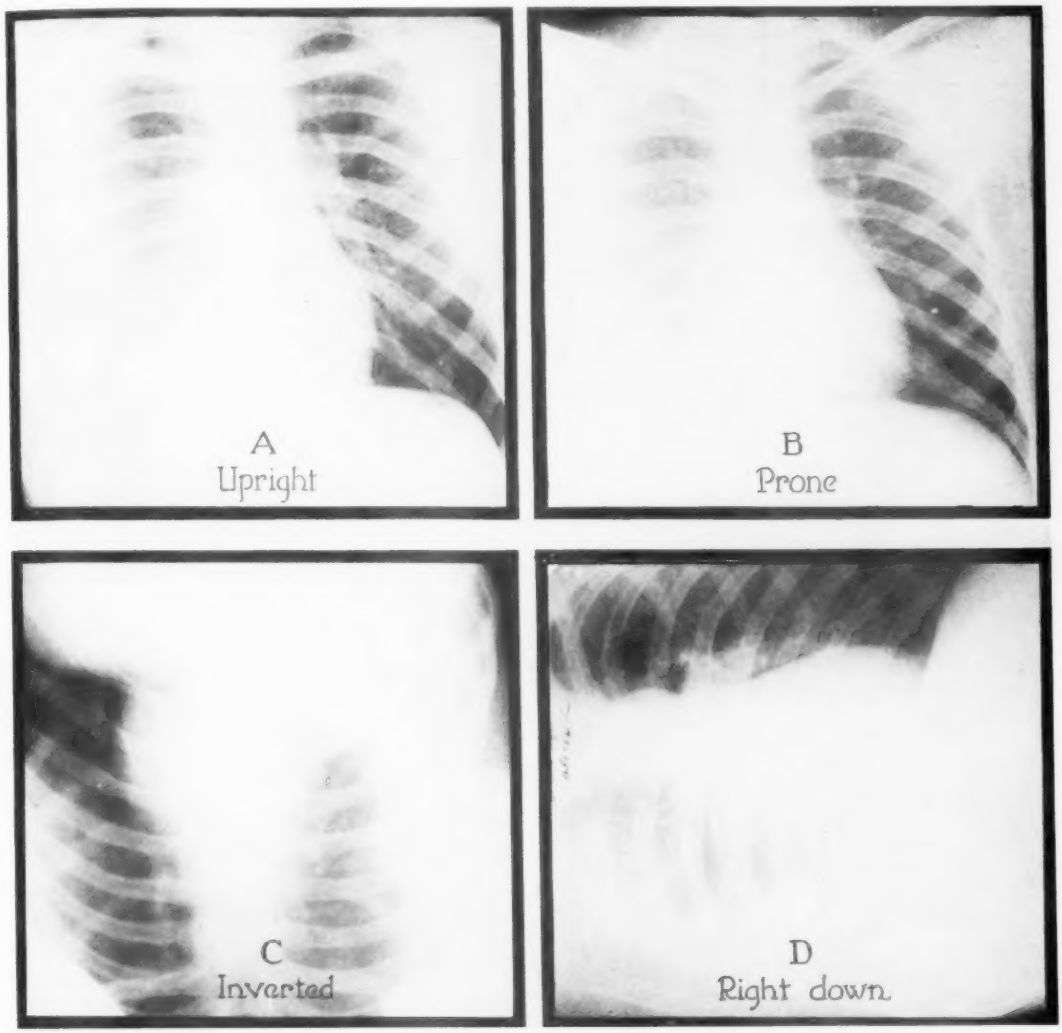

Fig. 3. Non-tuberculous inflammatory effusion of long standing, probably with adhesions. A. The typical appearance of fluid is shown in this position. There is a dense shadow on the right, obliterating the costophrenic angle and rising higher laterally. B. Change to the prone position makes very little change in the position of the fluid. C. The fluid curve is still maintained with the patient inverted. D. The right lateral decubitus position does not change the fluid level to any degree.

strong suspicion that sufficient adhesions might be present to account for the lack of shifting. A second case, tuberculous in origin, showed much the same findings. In this case fluid was also obtained readily by pleural puncture. Pneumothorax was then instituted and the numerous, large, firm adstanding inflammatory effusions tend to develop firm adhesions and, therefore, may show no movement. This lack of shifting is due rather to the partial encapsulation than to the peculiar physics of the pleural cavity.

In the majority of cases with inflamma-

tory fluid, definite and marked changes in the level of the fluid with different positions occurred. Such a case is illustrated in Figure 4, an extensive effusion being present on the right side. This fluid was tuberculous in origin, clearly an exudate, but had been present only a short period of time when first observed. It is notable that in the upright position (Fig. 4A) the upper surface of the fluid arises to the level of the fourth rib anterior. In the other positions the extreme changes in the level of the fluid

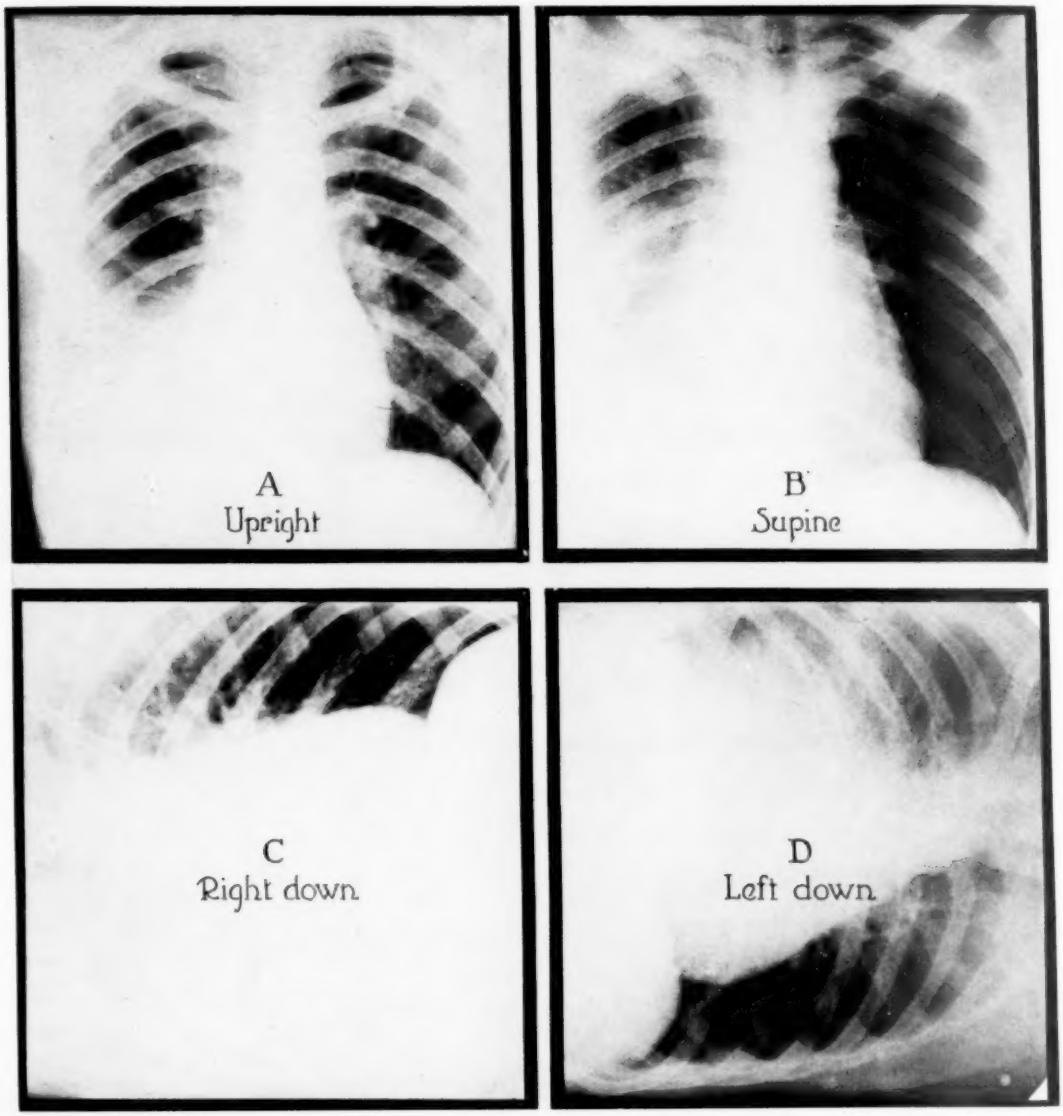

FIG. 4. Tuberculous pleural effusion, bilateral. A. The characteristic appearance of fluid on the right side is shown. Note the clear left diaphragm and costophrenic angle, showing no sign whatever of fluid. B. The fluid on the right side has shifted markedly with the change of the patient to the supine position. The left pleural cavity appears clear. C. In this position the fluid on the right has again shifted toward the apex. D. With the patient lying on the opposite side the fluid on the right has shifted toward the mediastinum leaving the periphery almost clear. Evidence of fluid on the left is now clearly visible as shown by the shadow in the inferior costal gutter running parallel to the long axis of the chest. Note the contrast with the appearance on the left in the other three positions.

are readily seen, the shift carrying the shadow well to the apex. Another case in this group demonstrates one of the diagnostic advantages to be derived from the observation of the movement of an effusion. This was an exudative effusion in the left pleural cavity secondary to a postoperative bronchopneumonia. Films made in the usual upright position (Fig. 5A) show the fairly typical signs of fluid although the upper surface of the shadow is rather flat. The patient was then placed in a partially inverted position, the hips being elevated above the head. Films made in this position (Fig. 5B) show the fluid to have migrated to the apex and the upper lobe of the lung is partially obscured. The lower lobe, however, while entirely invisible in the upright position is now quite well demonstrated. In this way tumors or other abnormalities in the bases of the lungs may become visible although completely obscured in the usual roentgenogram.

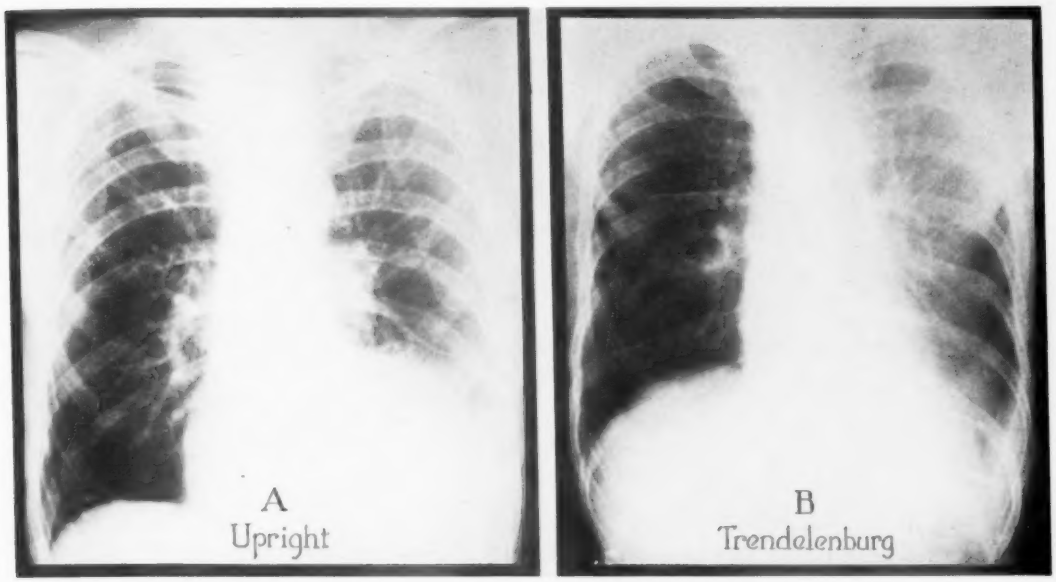

Fig. 5. Post-pneumonic pleural exudate, left. A. In the usual position the fairly typical appearance of a moderate effusion on the left is shown. Note the complete obscuration of the base of the lung, the left side of the heart and the left diaphragm. B. With the hips elevated above the head, the fluid shifts to the apex, clouding it. Note the visibility of the lower lobe of the lung, the heart, and the left diaphragm, made possible by the shifting of the fluid. Some shadow of fluid is still visible in the costophrenic angle.

The final group of cases consisted of pleural effusions, transudative in nature, arising from general circulatory or renal failure, or from the pressure of tumors. All of these showed, without exception, a shift of the fluid of marked degree with change in the position of the patient. A characteristic example of this type is shown in Figure 6. This was a case of lymphosarcoma with a secondary pleural effusion. The fluid was of low specific gravity and obviously not inflammatory in nature. In the upright position (Fig. 6A) the typical appearance of a pleural effusion on the left side is shown. In the prone position (Fig. 6B) the shadow changes radically, the whole left hemithorax becoming cloudy. The fluid has shifted, obviously, so that it now fills the whole chest on this side and obscures the apex and upper lobe completely. Although this degree of shifting of the fluid was rather extreme it was hardly more than that found in most of the cases examined. This case also illustrates the importance of making roentgenograms for the study of the apices

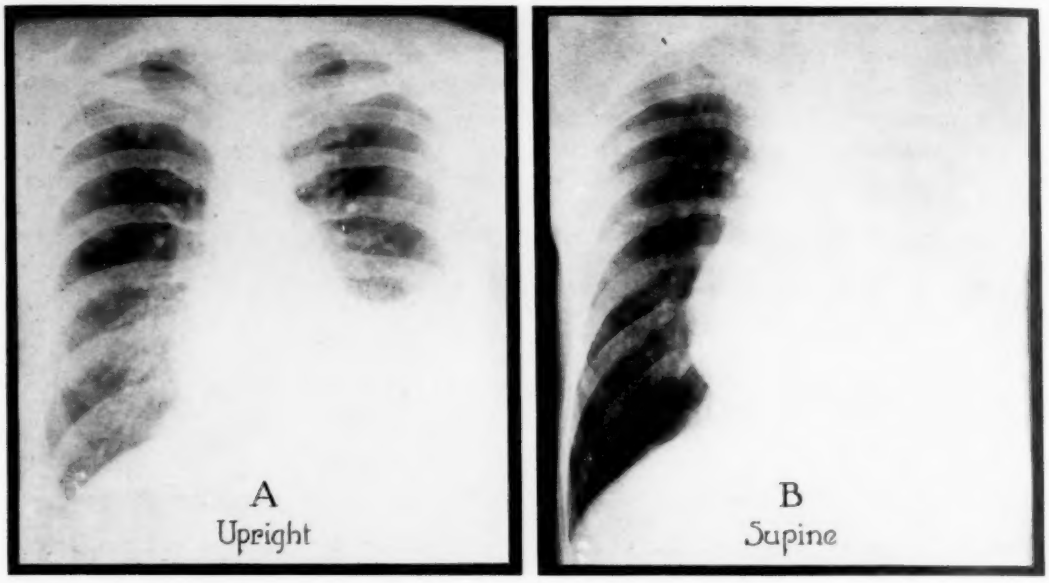

Fig. 6. Non-inflammatory left pleural effusion secondary to lymphosarcoma. A. In the usual position the fluid shadow is seen at the base, rising slightly on the lateral side. The upper lobe is clearly visible. B. In the supine position the fluid spreads throughout the pleural cavity obscuring the upper lobe completely.

of the lungs in the upright position. The possibility of a small unsuspected effusion always exists and it might shift to the apex in the recumbent position thus producing a faint cloudiness. This might effectively obscure the intimate lung detail which is so necessary for accurate diagnosis.

The importance of this demonstration of the movement of pleural effusions, aside from its scientific interest, lies in the aid which this phenomenon may render to earlier and more accurate diagnosis of pleural diseases. I have described in a previous presentation[11] the help which can be obtained in the earlier diagnosis of small pleural effusions by taking advantage of the shifting of the fluid. When it is considered that less than 400 c.c. of fluid in the pleural cavity cannot be detected by physical examination and seldom, if ever, by the ordinary roentgen examination,[5] the desirability of improvement in the technique of roentgen diagnosis in this field is apparent. This improvement has been accomplished by the use of the lateral decubitus position previously described (Fig. 1) and also used by Merlo Gómez and Heidenreich and Polgár. Thus the case illustrated in Figure 4, while showing the obvious effusion on the right side shows no evidence whatever of effusion in the left pleural cavity in three of the positions (Fig. 4A, 4B, 4C). In the left lateral decubitus position (Fig. 4D) a distinct linear shadow may be seen in the inferior costal gutter, its upper surface parallel to the long axis of the chest and obviously the evidence of a small left pleural effusion. The clear left costophrenic angle in the upright (Fig. 4A) and supine (Fig. 4B) positions should be noted. The effusion in this case was an exudate of tuberculous origin and the same findings have been obtained in a number of transudative effusions also.[11] The shift in the position of the small amount of fluid present in these cases, served either to demonstrate fluid which was unsuspected from the usual upright roentgenogram, or to differentiate a suspected small effusion in the costophrenic angle, from pleural thickening. The latter distinction is frequently exceedingly difficult; at times it is of great importance. Figure 7 illustrates a case of this type. As a result of cardiac failure a transudate ac-

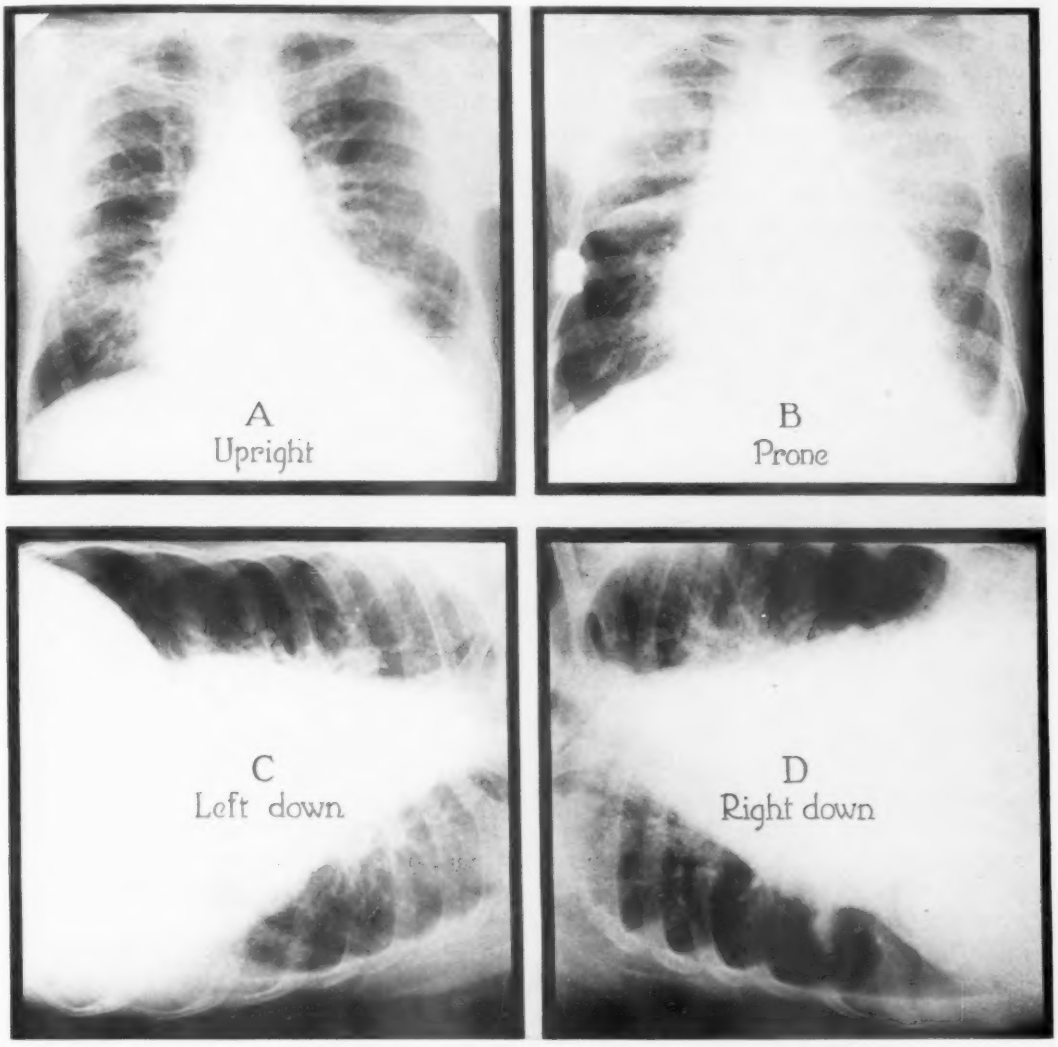

Fig. 7. Bilateral pleural effusion secondary to cardiac failure. A. A definite shadow of fluid is clearly shown on the left obliterating the costophrenic angle. The right diaphragm and costophrenic angle are clear though there is a fine line of density at the periphery. A faint "hair-line" shadow can be made out at the horizontal interlobar fissure. B. The fluid on the left has changed slightly in position. On the right there is now shown a triangular shadow in the horizontal interlobar fissure characteristic of fluid within it. This is due to free fluid in the pleural cavity passing into this fissure. C. Note the change in position of the fluid on the left and the change in appearance of the interlobar fissure on the right. D. With the patient lying on the right side the shadow of fluid in the right pleural cavity, hardly seen in the other three positions, can be clearly made out. It presents a linear shadow in the inferior costal gutter parallel to the long axis of the thorax.

cumulated in the left chest. This is obvious in the usual upright roentgenogram (Fig. 7A). On the right side, however, there is also a very slight shadow, at the periphery, resembling closely the appearance of pleural thickening. In the prone position (Fig. 7B) this shadow becomes more pronounced but there might still be some doubt from this as to whether it represented fluid. In the right lateral decubitus position (Fig. 7D) the shadow becomes much larger and more obvious making the diagnosis of pleural effusion unmistakable. The free movement of both these effusions in the four po-

sitions illustrated should also be noted. From the cases studied it appears that effusions which are sufficiently small to simulate pleural adhesions almost invariably show a distinct increase in the size of their shadow when the patient is put in the lateral decubitus position; under similar conditions cases of pleural thickening will show no change.

There is one further effect resulting from this change in position which may be of considerable value in differentiating pleural fluid from thickening. In a number of cases, roentgenograms made with the patient in one of the recumbent positions have shown clearly the shadow of fluid in the interlobar fissures, although in the upright position no sign of the fissure could be made out. This phenomenon has been previously reported by the author[11] and will be studied in greater detail later. It appears to be due to the shifting of a small amount of fluid into the neighborhood of the interlobar fissure, into which it is drawn. This is chiefly due, no doubt, to the high degree of capillary pressure exerted by the small space which is there present. This phenomenon is also illustrated in Figure 7. The film made in the upright position (Fig. 7A) shows a faint line in the region of the transverse interlobar fissure on the right side. In the prone position, however, the roentgenogram (Fig. 7B) shows definitely a dense triangular shadow corresponding to the horizontal (secondary) interlobar fissure between the middle and upper lobes on the right. The conclusion that the fluid in the right pleural cavity entered the interlobar fissures, with change in the position of the patient, is inevitable. In some of the other cases observed, so much fluid entered into the fissure that a triangular shadow—simulating closely that of an encapsulated interlobar effusion—was produced. This finding is a definite indication, therefore, of the presence of free fluid in the pleural cavity.

It is needless to add that all the above findings can be obtained by roentgenoscopy as well as in the roentgenogram. The latter has, of course, the same advantages in this type of study that it has in the investigation of any of the diseases of the lungs and pleura. The results of this study indicate that a marked improvement in the diagnosis of pleural diseases may be obtained by making a roentgen examination in a variety of positions, especially the lateral decubitus.

SUMMARY AND CONCLUSIONS

A series of cases of pleural effusion of all types were studied by means of roentgenograms made in the upright, prone, supine, inverted, and lateral decubitus positions. The results of this study seem to indicate the following:

1. All pleural transudates appear to move with a considerable degree of freedom with change in position of the thorax.

2. Most pleural exudates, especially those of recent origin and non-purulent character, appear also to shift markedly when the position of the patient is changed.

3. Pleural exudates of the purulent type and non-purulent exudates which have been present sufficiently long to develop adhesions may not change in position even when the patient is inverted.

4. Posteroanterior roentgenograms made with the patient in the lateral decubitus position may reveal pleural fluid which is completely invisible in the usual upright films.

5. With change in position of the thorax a shadow may appear in the roentgenogram, characteristic of fluid in the interlobar fissure, although entirely absent in the upright position.

6. Partially inverting the patient may cause fluid to pass from the base of the lung to the apex, thus uncovering the hitherto invisible portion of the lung and obscuring the upper portion.

7. The earlier diagnosis of small pleural effusions, the distinction between pleural fluid and pleural thickening, and the determination of pathological changes in the base of the lung, ordinarily impossible in the presence of a moderate effusion, may be accomplished by roentgen examination in a variety of positions.

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DISCUSSION

Dr. W. F. Manges, Philadelphia. This was a most excellent presentation. I think Dr. Rigler is to be congratulated on his technical results. It does please one to sit and look at a group of roentgenograms as consistently good as his were. This is a very important subject. I agree with everything he said and I think from the viewpoint of differential diagnosis that anything I might say would probably add nothing.

There are a few points, however, I would like to stress, and one is that the height of the fluid in the chest may depend a great deal upon the condition of the lower lobe of the lung on that side. You may have a very high fluid level with a comparatively small amount of fluid, if the lung is not in a collapsible state. That is the same condition seen in pneumothorax; where the tissue is diseased, it does not collapse so well as do those parts free from pathology. I think that all except encapsulated exudates move to a certain extent with the shift of the position of the patient. I think they have to. If you will center your tube over a given point on the chest with the patient in an upright posture, take a roentgenogram at full inspiration, and then have the patient lie supine with exactly the same relations and take another roentgenogram at full inspiration, you get an entirely different picture. The diaphragm is not at the same height with relation to the ribs or the vertebrae. The pressure of the abdominal organs compel it to change so that mechanically the fluid level must change. The fact that the clinician does not find such conditions in physical diagnosis means nothing. I think less of physical diagnosis the more I learn about roentgenology.

Effusions that extend into the apex of the chest should have careful consideration, particularly if the column is narrow along the axillary border about half way from the apex to the base; that is, if the effusion column or the exudate column is relatively wide at the base, then becomes narrow, then widens out again over the apex, that is a point of real surgical importance to be noted.

I know of an instance where a young man had an empyema that had that narrow band of density between the apex and the base. He had a basal drainage, so to speak, and the empyema at that point disappeared. That boy to this day, after a period of seven years, I think, still has a localized empyema in the apex of his chest. It was never drained. He has a bronchial fistula and is not fit for any further surgery.

Changes take place when you put the patient in the lateral view. Again, you must take into consideration the lateral movement of the mediastinal structures. If you will recall how the mediastinum will shift under the influence of certain types of foreign bodies, you can see what a movable structure it is and how it may

change and how it does change the position and the disposition of the fluid within the chest.

Dr. D. R. Bowen, Philadelphia. Dr. Rigler is to be congratulated on his paper. It is just another instance of the fact that improvement in technique is a removal of a handicap to diagnosis.

I particularly want to speak, however, of what I think is the best thing I ever did. I have published it twice, demonstrated it a great many times, and think it has not received enough attention. That is a canvas top stretcher which, after the patient has been lifted on the bedsheet, is placed under the patient, the patient lowered upon it and then taken where we please and postured almost as we wish. When a patient is ambulatory, a great deal of this work is very easy; an upright and a lateral position are perhaps enough. The patients I refer to are not ambulatory and one needs an upright fluoroscope, before which this stretcher can be used, and one in which neither the screen frame nor the shutter control interferes with the horizontal position of the patient. So far as I know, there is only one such type of fluoroscope and it is obsolete, but I have one. You can rotate your patient. The clinician always does it. He usually sets him up for "physical" but he won't allow the roentgenologist to do so if he can help it and, ofttimes in the fluoroscopic room, it is otherwise undesirable. A patient on this stretcher can readily be placed in any desired degree of horizontal rotation for the demonstration of fluid movement or fluid level.

Dr. Rigler (closing). I have been very much interested in a point Dr. Manges brought up in regard to the position of the fluid with relationship to the condition of the lung behind it. I at one time thought we might be able to predict something as to the amount of cirrhosis, if we should call it that, fibrosis or rigidity of the lung, by the amount of curve which the fluid presented, as Dr. Manges pointed out. It is rather strange, however, if you run through a series of cases, that they do not appear to be consistent along this line. You would expect, for instance, in children, in view of the relatively good condition of the lung, that collapse would take place quite readily and therefore, in children you would not very frequently see the ribbon-like shadow along the margin of the chest. As a matter of fact, the latter is more frequent in children than in adults, let us say, with cardiac decompensation. In these the lung is usually quite rigid and yet we usually see a rather flat level to the upper surface of the fluid.

With regard to Dr. Bowen's comment about the apparatus, I might say we have had some little difficulty in getting our patients in this position and the ideal apparatus, I imagine, if fluoroscopy is going to be done, is some arrangement such as the Carelli table. We have done, for purposes of fluoroscopy, as he suggested, putting the patient on a stretcher and putting it in front of a vertical fluoroscope. Most of the patients that I showed here were reasonably ambulatory and the technique was comparatively easy. With some of them, of course, it is much more difficult.

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THE COMPRESSION OF TUBERCULOUS CAVITIES BY ARTIFICIAL PNEUMOTHORAX

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THE importance of cavitation in pulmonary tuberculosis need not be emphasized to physicians who know that disease. The menace of the cavity, being the focus for pulmonary hemorrhage and the source of the bacillary sputum causing the dreaded bronchogenic extension, is brought to his attention continually. Statistics bear out his observations that a cavity is an ever-present potential danger to his patient's life. Barnes and Barnes[1], in a review of 1454 tuberculous patients with cavity, found that 80 per cent died within one year and 85 per cent within three years. The average duration of life was twelve months. In a small percentage of cases remarkable spontaneous closure of antra is seen, but the clinician interested in compression therapy is seldom tempted to assume a watchful waiting policy in his treatment because of a few isolated instances,—too often he has seen rapid enlargement or the "closed" cavity reopen and, while waiting, his patient becomes a hopeless case because of an extension of the disease into the contralateral lung.

Douglas et al.[2] in a report based on the study of 200 cases, found that in 52.5 per cent the onset of the disease was sudden; of 27 patients whose duration of symptoms was six months and less, 22 showed cavitation, a percentage of 81.5. Such figures show us how alert we must be that we do not overlook cases in which compression therapy may be at once indicated. It is in such observation that serial roentgenographic study is almost indispensable. Cavities may form in a surprisingly short period of time, and symptoms, outside of usually increased expectoration, may fail to tell us of the onset of the new hazard.

To the physician doing pneumothorax work, the cavity is the thing on which his attention is most closely centered; antra most often constitute the indication for inducing this type of compression therapy. The approximation of cavity walls, with the resulting lessening or stopping of expectoration along with a non-bacillary sputum, is the most important thing sought; with these usually comes clinical improvement.

It is not amiss for clinicians to give a thought to the pathology of cavities. Pinner[3] has divided cavities roughly into three groups:

1. Small multiple cavities (described in the roentgenogram as a "moth-eaten" appearance). These are most often seen in exudative processes and may appear early and rapidly; they are potentially larger areas of excavation as they can quickly progress to form large antra. Pathologically the small multiple cavities represent a loss of substance in the midst of a caseous pneumonia.

2. "Round" cavities. These approach sphericity and may either have extensive perifocal inflammation or well-defined, sharp borders. Pathologically this type of cavity may present a heavy border of caseous pneumonia, or a mantle, varying in thickness, of fibrous tissue.

3. Irregularly shaped cavities. This variety has dense walls, the inner surfaces of which are often trabeculated. Such cavities are most often seen in or around the apical region with adjacent pleura greatly thickened. A productive type of disease is usually the causative factor in the formation of these cavities.

In a comparatively few cases some difficulty may be encountered in determining, roentgenologically, into which group a certain cavity falls as one sees varied transitional forms.

The pathology of the cavity is of importance to the clinician because its type indicates approximately the resistance of the pulmonary parenchyma to the disease

process. The "moth-eaten" appearance in the midst of an exudative lesion is usually indication enough to start collapse therapy, while possibly the procedure may not have to be hurried as much in the case of cavities showing well-defined walls, for the surrounding tissue is showing some tendency to hold the lesion, at least temporarily, in check. But regardless of the type of cavity its presence, providing it is showing no immediate tendency to close spontaneously, calls for collapse therapy.

There are several factors determining whether or not a cavity can be satisfactorily compressed by pneumothorax treatment. Were it not for these factors the relative ease of compressibility of the different types of cavities described above could be determined fairly easily.

1. *Pleural Adhesions.* Physicians interested in artificial pneumothorax need not be told that pleural adhesions present the greatest and most common barrier to a perfect closure of a cavity. Not only do such adhesions, in a certain percentage of cases, block the operator from finding a free pleural space, but even in the face of a pleural space with sizable capacity for air they may make compression of a cavity slow or even impossible.

Pleural adhesions, as shown by any pneumothorax series, most often are found in the upper one-third (and especially the apical region) of the lung; this is especially significant because the majority of cavities are also found in this portion of the organ. Thus adhesions overlying a cavitated area are too often the bugbear of the physician doing pneumothorax work. Rather remarkable instances are seen where adhesions slowly stretch allowing the lung finally to be compressed. It is usually unsafe to predict as to an adhesion's stretching capacity unless it is extensive.

2. *The Type of Pathology in the Adjacent Lung.* If the cavity lies in the midst of a dense fibrotic lesion collapse may be impossible or very slow. Exudative lesions, unless especially dense and extensive, usually yield well to pneumothorax compression; cavities in such type of lesions often retain patency for a considerable length of time and may close only when the exudative process begins to clear. On the other hand, if the exudative infiltration be light, compression may be obtained rather quickly, with resulting approximation of cavity walls. Occasionally, in a malignant exudative disease, one sees cavities enlarge even in the face of a well-collapsed lung.

3. *The Type of Cavity.* The type of cavity yielding most readily to compression therapy is the small multiple variety. These are the youngest cavities seen and if the surrounding lung lesion is not too dense they may be compressed in a surprisingly short time by pneumothorax. The "round" cavities, extremely common, may often be

TABLE I

Type Cavity	Number	Type of Lesion Associated			Result on Cavities			Cavities Closed per cent	Sputum Became Negative per cent	Average Time Required for Closure of Cavity
		Exudative	Productive	Mixed	Closed	Smaller	Unimproved			
Small multiple	5	3	1	1	5	0	0	100	100	7 mos.
"Round"	22	9	7	6	14	5	3	63.6	63.6	6.5 mos.
Irregular	4	1	2	1	0	2	2	0	25	—

satisfactorily compressed too, but the pathology of their walls is an important factor in their collapsibility. Such cavities with thin walls resist compression poorly, but those having a thick fibrotic wall may be very difficult to close. The difficulty in controlling such a cavity with fibrotic wall is well illustrated in one of our cases where other factors interfering with collapse were absent; this particular cavity was driven into the vertebral gutter where it remained much smaller than initially, for about three months and finally was fully compressed after ten months. Irregularly shaped cavities with thick walls often fail to be compressed because of the interference of heavy pleural adhesions adjacent to them. In the case of thin-walled cavities one often sees a change in their position and size following a small initial pneumothorax. This is brought about by the release of the tension in the surrounding lung which is a factor in keeping the cavities' walls apart. We have observed such a thin-walled cavity at post mortem; with the affected lobe held in the hand, the cavity walls approximated perfectly without exerting positive pressure. The moral to be derived from the above experience with antra is to start, if possible, a compression therapy early before the cavity has had a chance to build up its protecting wall of fibrosis.

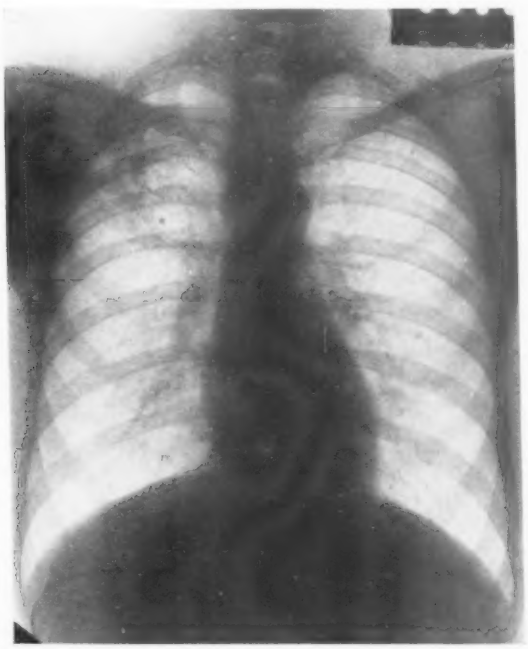

Fig. 1. Case 1. Male, aged twenty-five. Symptoms: loss of strength; pulmonary hemorrhage of 5 oz. twenty-three days previous to date of roentgenogram; sputum negative. A good example of an exudative lesion with small moth-eaten area which, with hemorrhage, created the indication for artificial pneumothorax therapy

Fig. 2. Case 1. Roentgenogram taken two months, twenty-five days after Figure 1. Manometric pressure −1–3. Cavity completely compressed.

4. *Shifting Mediastinum.* A rather uncommon condition helping to defeat compressibility of cavities is a shifting mediastinum. In such cases, when marked, there is no stable structure mesially for the lung to be compressed against and any pressure put upon the lung laterally is counteracted by the coincident movement of the mediastinal structures. With this complication compression has to be carried on cautiously in order to avoid untoward symptoms.

There is some disagreement as to the proper pressure to reach and maintain in pneumothorax therapy. There are those

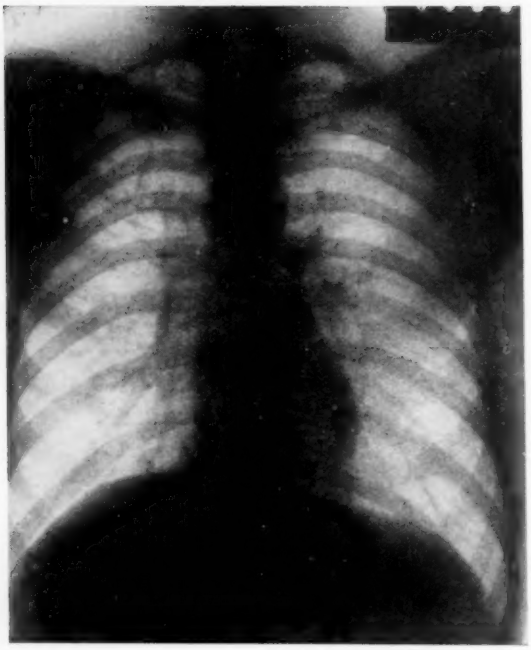

FIG. 3. Case 11. Male, aged twenty-six. Symptoms: irritative cough productive of small amount of bacillary sputum. Roentgenogram taken five months after onset of symptoms. Indications for artificial pneumothorax: cavity; positive sputum. Showing example of a "round" cavity.

who advise a relatively high positive pressure. In our series only occasionally have we found it necessary to reach a maximum of more than 0 to +2, and many successful collapses have been seen with a maximum manometric pressure of 0 to −4; such pressures are thought to be safer than high readings and do not result in unpleasant symptoms for the patient. After the fixed state of the mediastinum is proved, and the patient's reaction to pressures determined, rather high pressures (+10, +20) may be carried out if needed to get an efficient collapse. It seems unwise to try deliberately to stretch pleural adhesions by means of high pressures; we think the end-results of such stretching may be obtained by rather frequent refills and moderate pressures.

Serial roentgenograms of 31 pneumothorax patients were studied. This series, although small, probably represents an average cross-section of any larger group of such cases; indication for collapse therapy was clear in all; only 3 of the patients might be called "last chance" or desperate problems.

Qualitatively the lesions were classified as (1) exudative, (2) productive, and (3) mixed. Of the first type there were 13 cases, of the second 7, and of the third 11.

The frequency of pleural adhesions was shown by the fact that only one case was entirely free from them. Collapse of cavities was definitely interfered with by adhesions in 5 cases; 3 of these cases were productive lesions while 2 were of the mixed type. In no case did adhesions interfere with the final closure of cavities in exudative cases. Marked stretching of adhesions was seen a number of times and especially in 2 cases with exudative lesions. Apical and subapical location of adhesions was seen in 27 cases; mid-lung and basal location was seen in only 3 cases.

Rather marked mediastinal shifting was observed in one case, partially interfering with a good collapse of cavities.

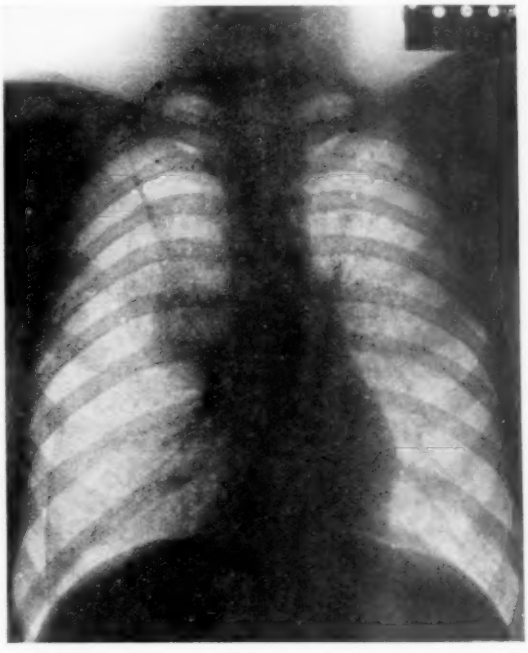

FIG. 4. Case 11. Roentgenogram taken seven months after Figure 3. Sputum negative. Showing complete compression of a "round" cavity—selective collapse. Manometric pressure 0–1.

As regards location of the cavities, one was strictly apical, 23 were infraclavicular, 5 were found in mid-lung region, while 2 cases showed a scattered location.

Using the classification of cavities already described, the antra were divided as follows: Small multiple, 5; "round," 22; irregular, 4.

Cavitation was favorably influenced, the antra being closed or smaller, by pneumothorax treatment in 83.8 per cent of the cases. The result of compression therapy in the different groups of cavity is seen in Table 1. These results cannot be termed final as a few of the cases have not received pneumothorax long enough to expect the maximum result.

Ten cavities in the 13 exudative lesions were closed—a percentage of 76.9. In the 7 productive lesions 5 were closed, or 71.4 per cent, while in the 11 mixed lesions 4 were closed, or 36.3 per cent.

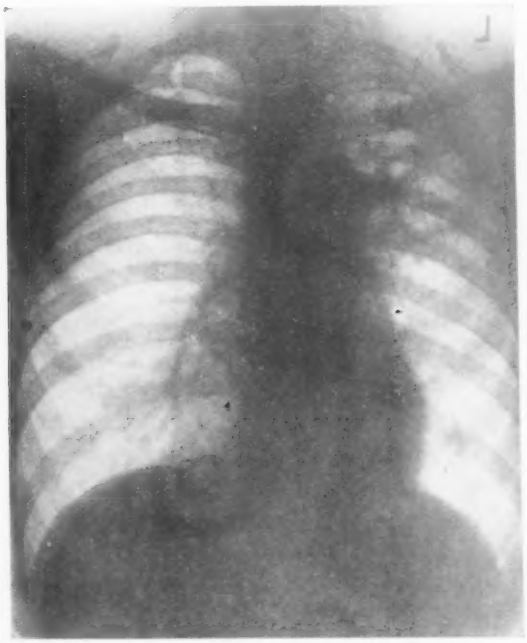

Fig. 5. Case III. Male, aged thirty-eight. Symptoms: productive cough, moderate fever, left-sided pleurisy, loss of weight. Roentgenogram taken seven months after onset of symptoms. Indications for pneumothorax treatment: cavity; positive sputum. A rather typical irregular cavity, adjacent pleural involvement.

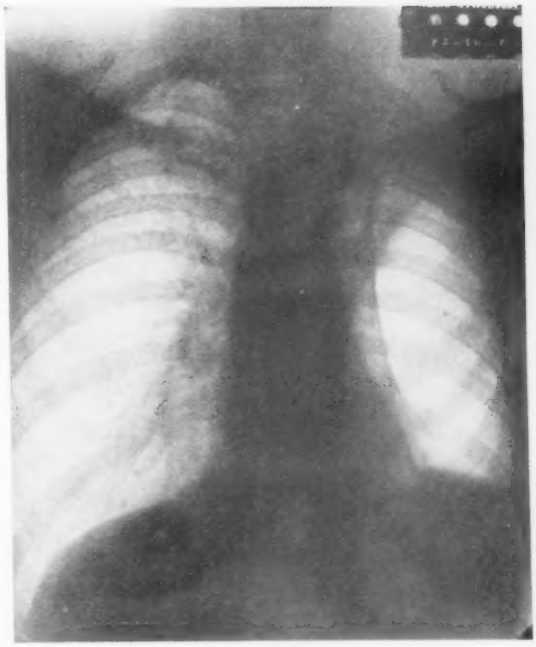

Fig. 6. Case III. Roentgenogram taken two years, five months after Figure 5. Cavity remaining patent. Moderate amount of expectoration.

In the case of 10 cavities for which the reason for their remaining patent could be fairly satisfactorily determined, pleural adhesions were the cause in 5, heavy infiltration in 3, movable mediastinum in one, and thickened fibrous cavity walls in one. Of the 5 cavities whose compression was not obtained because of adhesions, 3 were irregular and 2 were round.

Non-bacillary sputum was obtained in 17 cases out of 29 which had previously been positive.

The time required for closure of the cavities under compression therapy was approximately determined in 19 cases. The time in 5 cases of small multiple cavities averaged seven months; the minimum and maximum was two and twelve months; this maximum time, along with another case which required ten months, was seen in an extensive heavy exudative lesion. Fourteen "round" cavities required an average of 6.5 months for their closure, with a minimum of two months and a maximum of eleven months. There are so many factors

entering into the time required for closure that it may vary markedly.

We think a study such as this is worth while and the data so gained will be useful to anyone doing compression therapy. The qualitative diagnosis of cavities, grouping them according to the classification which has been mentioned, may materially aid us in our prognostication as to their compressibility. Cavities of the small multiple variety (as shown in Case I, Figs. 1 and 2) are as a rule quite readily compressed; those grouped under the "round" variety (shown in Case II, Figs. 3 and 4) can be compressed in the majority of instances. This thin-walled type of cavity is also often satisfactorily influenced by the relaxation mechanism of phrenicectomy. Irregularly shaped cavities (as pictured in Case III, Figs. 5 and 6) because of their thick walls and the possibility of overlying pleural adhesions are especially questionable as to their chances of being compressed. Prognostication in tuberculosis is very difficult at best but we find that careful observation will help us in the problem and teach us that we can go further than to merely diagnose cavity and the extent of the lesion.

CONCLUSIONS

1. The classification of tuberculous cavities according to the structural characteristics of their walls, as seen roentgenologically, is possible to a certain degree of accuracy and yields data of definite value for clinical work. The classification into the three groups mentioned affords a rough means of prognosticating the collapsibility of antra under pneumothorax therapy.

2. The three principal factors influencing the closure of a cavity under pneumothorax treatment are (1) pleural adhesions, (2) the histologic structure of the cavity wall, and (3) the type of lesions surrounding the cavity.

3. Artificial pneumothorax offers an efficient measure for cavity compression but should, when possible, be used early, chronologically, in the disease before antra have had time to develop a heavy fibrous wall.

4. The result of pneumothorax treatment in 31 patients grouped according to the pathologic-anatomic nature of the lesions is reported.

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PNEUMOTHORAX*

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CURIOSITY and numerous discussions with various clinicians prompted us to review some 28 cases of pneumothorax. Much has been written regarding the changes that occur following the admission of air into either pleural sac. It has often been said that the heart is displaced to the opposite side, and that the diaphragm is elevated on the affected side.

It is usually stated in textbooks that the interspaces are widened, and the chest on the affected side bulges. It was these changes we intended to study, to try to determine whether the heart is always displaced, whether the diaphragm is depressed or elevated, and what changes take place in the thoracic cage.

I shall not review here the symptoms or physical findings. The mechanics of pneumothorax are indeed very interesting. It is hard to say why in some cases the lung will be completely collapsed and be located close to the midline and still the heart will be in its normal position or only slightly displaced. In this same patient, the diaphragm will be depressed. In another patient, the lung will be partly collapsed and there will be great displacement of the heart and mediastinum and the diaphragm will be elevated.

Some time ago we talked with Dr. Curtis Lyter of St. Louis who is doing considerable work on intrathoracic pressure. He has made an instrument whereby with the aid of a mercury tube he can compute the intrathoracic pressure on both sides. At the time we talked with him, he was working on pneumothorax and emphysema. He had some interesting figures and the work may be of value scientifically when completed.

There seems to be no general rule regarding the amount of displacement of the heart and mediastinum. The amount of air that enters the pleural sac does not seem to be the determining factor.

For some time we thought adhesions were the cause of the heart and mediastinum retaining their normal positions. This fact, however, we could not prove, as there seemed to be practically no evidence of adhesions in many cases that showed no displacement even when the lung was completely collapsed. We have noted a number of patients showing only partial collapse of the lung and still there was much displacement of the heart and mediastinum.

In patients having spontaneous pneumothorax there is a sudden escape of air from a ruptured alveolus into the pleural sac. If the opening is small and closes, there will be no further escape of air. The pressure will be increased for a short time and then gradually the air will become absorbed and the pressure equalized. If the opening is large and remains open, there will be air passing from the lung to the pleural cavity continuously. It has been our experience that the more extensive the disease, the longer it will take the lung to resume its normal position. It is not uncommon to see a lung that has been completely collapsed following a stab wound, return to its normal position a in very short time.

In a pneumothorax due to a tuberculosis, it is not uncommon to find the lung collapsed for many months. These cases often develop pus in the pleural sac.

It has often been said that a spontaneous pneumothorax is always due to tuberculosis. It is true that tuberculosis is often the cause of spontaneous pneumothorax, but we have seen many cases with no evidence of tuberculosis either roentgenographically, clinically or symptomatically. We do not believe, however, that a normal lung will collapse following some slight ex-

* Read at the Twenty-ninth Annual Meeting, American Roentgen Ray Society, Kansas City, Mo., Sept. 25–28, 1928.

ertion that the pneumothorax is attributed to. There must be some disease present, even though we cannot identify it.

For some time we made observations following and during the treatment of pneumothorax. It is not uncommon to start patients blowing on bottles immediately. It is our opinion that this practice is carried out too early and too long in many cases. In a recent pneumothorax, the increasing of the pressure in the debilitated lung may open the rent in the lung and let more air into the pleural sac. It is our belief that these cases should not be put on this form of treatment early, and it should not be prolonged as more harm than good may be done.

It is also possible that in markedly diseased lungs the blowing may cause a rupture through some weak spot in the other lung.

Therapeutic pneumothorax is practised quite extensively by many noted internists. It is our opinion that this form of treatment should be used only after careful study. The internist should be sure the other lung is capable of carrying on the work of both lungs. It is often hard to say following a hemorrhage which lung is the offender. Dr. Robert Preble has made the remark many times—"Be sure you know which lung is bleeding, and know the capacity of the other lung to carry on under the addition of the extra work."

ROENTGEN FINDINGS IN TWENTY-EIGHT PATIENTS WITH PARTIAL OR COMPLETE PNEUMOTHORAX

28 cases / Case No.	Heart Displaced	Diaphragm Elevated or Depressed	Lung Collapse Partial or Complete	Fluid	Tuberculosis Infection Injury	Trachea Displaced	Thorax Bulging Retracted
H.L. 18025	Yes	Obscure	Complete	No	Infection	No	No
R.M. 21100	Yes	Depressed	Partial	No	Injury	No	Bulging
D.R. 25481	No	Depressed	Complete	No	T.B.	No	No
E.W. 22091	Yes	No	Complete	No	Infection	Yes	No
G.H. 22967	Yes	No	Complete	No	T.B.	Yes	No
M.B. 26146	Yes	Obscure	Massive Complete	No	Injury	Yes	No
R.B. 22797	No	No	Partial	No	Infection	No	No
L.S. 5105	Yes	No	Partial	No	T.B.	No	No
G.P. 9286	No	No	Partial	No	T.B.	No	No
S.C. 13405	Yes	No	Complete	No	T.B.	Yes	No
D.A. 16066	No	No	Complete	No	T.B.	No	No
R.W. 10074	No	No	Partial	No	Infection	No	No
G.C. 12294	No	No	Partial	No	T.B.	No	No
W.W. 8478	No	Depressed	Complete	No	T.B.	No	No
I.D. 11179	Yes	Depressed	Complete	No	Injury	Yes	No
E.S. 6697	Yes	Depressed	Complete	No	T.B.	Yes	No
H.W. 7262	No	No	Partial	Yes	Infection	No	No
T.T. 14615	Yes	Depressed	Partial	Yes	Infection	No	No
C.S. 10805	Yes	Elevated	Partial	No	T.B.	No	No
F.S. 9610	Yes	No	Partial	No	Infection	No	No
S.R. 7395	No	No	Partial	No	T.B.	No	Retracted
W.R. 11984	No	No	Partial	Yes	Injury	No	No
M.P. 15361	No	Obscure	Partial	Yes	Injury	No	No
E.O. 10116	No	No	Partial	No	Injury	No	No
E.M. 10147	No	Elevated	Partial	Yes	Infection	Yes	No
L.E. 9539	No	No	Partial	No	Injury	No	Retracted
L.D. 16740	Yes	No	Complete	Yes	Injury	No	No
N.R. 10371	Yes	No	Partial	No	Infection	Yes	No

I am sure we have all seen patients who were having hemorrhages, and from the film we were not sure from which lung the blood was coming. Furthermore, we are not always sure that the lungs are really diseased.

Some months ago, we had the opportunity of studying a traumatic pneumothorax. This patient had a serious stab wound of the chest. Following the wound the lung collapsed and the pleural sac filled with blood which later became infected and pus developed. The patient was drained constantly but showed very little improvement. The lung remained collapsed and the heart and mediastinum were displaced to the opposite side. The overlying pleura became progressively thicker, which was proved at operation.

This patient blew on bottles for months but very little improvement followed.

At the time the blowing was going on, a large drain was kept in the pleural sac. We believe it would have been impossible to expand the diseased lung, even after the wound had healed, as long as the large drain was left in the chest. The pressure from the outside would certainly effect what pressure could be obtained by blowing. Finally the lung became adherent and firm and operation was resorted to. The operation was extensive — attempting to collapse the chest wall (Shady) from which the patient succumbed. The pleura at opera-

Heart Displaced	Yes	14
	No	14
Diaphragm	Elevated	2
	Depressed	6
	No change	17
	Obscure	3
Lung Collapse	Complete	11
	Partial	17
Fluid	Yes	6
	No	22
Etiology	Tuberculosis	11
	Infection other than T.B.	9
	Injury	8
Trachea Displaced	Yes	8
	No	20
Thorax	Bulging	1
	Retracted	2
	No change	25

tion was said to be over an inch thick.

It is our opinion that this patient would have improved if the opening in the chest had been closed, and the patient allowed to blow on bottles. It is impossible to expand the lung with a large tube in the pleural sac. The tube was 2 cm. in diameter and would certainly keep the pressure in the sac increased, which would not be equalized by blowing on bottles.

It is pertinent at this time to mention some points regarding roentgen examination of these patients. Films taken in the horizontal position will often show the lung in its normal position when in fact it has not been completely expanded. If films are taken in the upright position, the upper lobe will often be found still collapsed. It is not uncommon to find the apex at the level of the second rib anteriorly.

PULMONARY INFECTION IN TULAREMIA

CASE REPORT

By L. R. SANTE, M.D.
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THE increasing occurrence of tularemia has rendered this disease of increasing importance in the field of medicine. In reviewing the literature we were unable to find any instances in which pulmonary involvement was mentioned as a feature of the disease. On this account we felt justified in reporting the following case in which pulmonary involvement produced prominent symptoms.

M. G., white male, admitted to St. Mary's Hospital, Nov. 25, 1929, on the service of W. E. Hennerich to whom I am indebted for this report. On entrance the patient complained of chills, fever, headache, general malaise and swelling of the right index finger. The patient was a butcher by trade and four days prior to his entrance, while cleaning rabbits, had scratched his right index finger. This was followed by pain, swelling and ulceration. The left index finger later developed a sore also, although he had no recollection of injury in this location. At the time of entrance he had some shortness of breath, but no cough or pain in the chest.

The past history gave nothing of significance.

Physical examination revealed ulceration, redness and swelling of both index fingers. Lymphangitis was present in the arms and there was bilateral adenopathy of the epitrochlear and axillary nodes. His pulse was rapid, ranging as high as 120 per minute, and his temperature reached 103.8° F. on his second day in the hospital. The white blood count was 14,400. Differential count showed: stabs, 1 per cent; segments, 61 per cent; small lymphocytes, 26 per cent; large lymphocytes, 9 per cent; monocytes, 3 per cent. On entrance there was some dyspnea and a slight grunt on expiration. Physical examination of the chest, however, failed to reveal any definite lung consolidation; expansion was equal on both sides; no other physical findings were of significance.

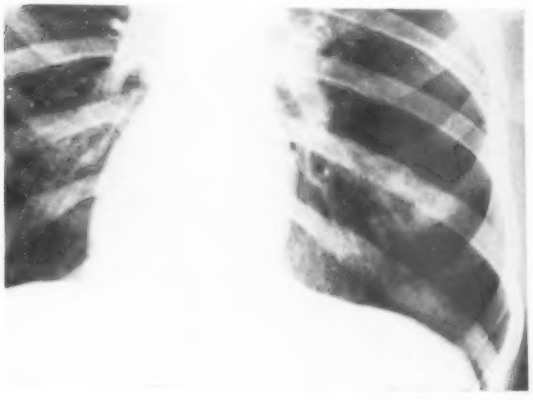

FIG. 1. Small irregular area of consolidation in right lower lobe with areas of lung destruction.

FIG. 2. Examination some months later showing restoration to normal. (Courtesy of Dr. M. H. Bachman.)

Culture of the pus from the wounds of the fingers and from the blood, on brain-heart infusion and brain-veal agar showed small aerobic, gram-negative, non-spore bearing, nonmotile bacilli. They caused fermentation on media containing dextrose, producing acid. Bipolar forms were occasionally seen (*Bacterium tularense*).

By seven days after the onset the pain in the thumb had disappeared and the temperature had subsided somewhat. However, a persistent non-productive cough had developed. There were no definite physical findings of lung pathology. Roentgen examination, however, disclosed evidence of pathology in the lower portion of the right lung which was reported

as follows: "There is an irregular area of consolidation about 2.5×4 cm. in the lower portion of the right lung. The consolidation is irregular in appearance, and resembles the peribronchial infiltration seen in bronchopneumonia. Tiny rarefied areas within the consolidation may be due to small abscess formation. There is no evidence of pathology elsewhere in either lung. The heart and aorta appear normal" (Fig. 1.).

The cough and the pain in the chest persisted for two weeks from the time of onset when the patient developed an acute pain in the upper portion of the chest, followed by a coughing spell. This was not attended with any extensive expectoration of pus. After this the pain in the chest and dyspnea gradually subsided, and roentgen examination some months later revealed complete disappearance of the consolidation and restoration of the lungs to normal (Fig. 2). The patient made an uneventful recovery.*

* I am indebted to Dr. M. H. Bachman for the second chest examination.

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THE ROENTGENOLOGIC DIAGNOSIS OF STENOSIS OF THE DESCENDING ARCH (COARCTATION) OF THE AORTA*

By A. CARLTON ERNSTENE, M.D., *and* SAMUEL A. ROBINS, M.D.
BOSTON, MASSACHUSETTS

BECAUSE of the difficulties in diagnosis, the adult type of coarctation of the aorta frequently is overlooked clinically. Only 21 of the 200 cases with necropsy collected by Abbott[1] were recognized during life, although obstruction of the thoracic aorta was diagnosed in 7 other instances in the series. The most important clinical criteria of the condition are: (1) the presence of arterial hypertension in the upper extremity as contrasted with low blood pressure in the legs; (2) retardation and diminution of the arterial pulses in the legs, and (3) evidence of extensive collateral circulation as manifested by forcibly pulsating, dilated arteries in the neck and thoracic wall. The purpose of this communication is to emphasize certain roentgenographic and roentgenoscopic findings in coarctation, the diagnostic significance of which we have been able to verify by post-mortem studies.

Railsback and Dock[4] recently directed attention to the fact that the enlarged, tortuous intercostal arteries, taking part in the collateral circulation in coarctation of the aorta, cause extensive erosion of the inferior borders of the ribs bilaterally and give a characteristic appearance in the roentgenograms of the thorax. At times, as in the case reported by Hamilton and Abbott,[3] absence of the third left (aortic) arc in roentgenograms of the heart and aorta may indicate the excessive narrowing at the point of stenosis; and in some subjects, the area of constriction can be detected on roentgenoscopic examination.

In the case reported here, opportunity was afforded to corroborate the roentgenographic and roentgenoscopic findings by necropsy. After death, the arterial vascular system was injected with a suspension of barium sulphate in agar and sodium iodide solution, and additional roentgenograms were taken to verify certain of the observations made during life. Detailed clinical data on this patient have been reported in an earlier communication[2] and will be reviewed only briefly.

REPORT OF CASE

D. W., a white teamster, aged forty-seven, had experienced cramps and weakness of the legs for five years, shortness of breath and cough for four months, and palpitation of the heart and vise-like pressure referable to the upper sternum for several weeks. On physical examination, the subclavian and carotid arteries showed heaving systolic pulsations in both sides of the neck, and several tortuous, visibly pulsating vessels were noted over the back. The area of relative cardiac dullness was slightly enlarged. A soft systolic murmur was heard over the mitral area, and a harsh systolic murmur was audible in the supraclavicular fossae, the axillae, and over the great vessels of the neck. The radial pulses were equal and of high tension. The femoral arterial pulsations were feeble, while the popliteal and posterior tibial pulses were barely palpable. The right and left brachial blood pressures were equal and averaged 164 mm. of mercury systolic, 94 mm. of mercury diastolic. The systolic blood pressure in the femoral artery was 88 mm. of mercury, and the diastolic pressure, 76 mm. of mercury. Tracings of the radial and femoral pulse waves showed that the femoral wave, instead of preceding the radial wave by 0.01 to 0.02 seconds as normally, followed the radial wave by approximately 0.15 seconds. There was characteristic flattening and prolongation of the femoral pulse wave. Pulsation of the abdominal aorta could not be felt. There were a few superficial, dilated, pulsating arteries in the upper abdominal wall.

* From the Medical Research Laboratories, Beth Israel Hospital, and the Department of Medicine, Harvard Medical School, Boston.

FIG. 1. Roentgenogram of the thorax showing bilateral erosion of the lower borders of the ribs due to prolonged pressure from the dilated, tortuous intercostal arteries. The scalloping extends forward approximately to the posterior axillary line.

Roentgenograms of the chest showed extensive irregularity of the inferior borders of the ribs on both sides, extending forward approximately to the posterior axillary line (Fig. 1). This deformity was presumed to be due to erosion by the pulsating, tortuous vessels of the collateral circulation. The cardiac measurements, according to a 7 foot roentgenogram, were normal.

Roentgenoscopy of the chest (by S. A. R.) showed a moderate degree of pulmonary emphysema. Forcible pulsations were visible at the base of the heart and in the ascending portion of the aorta. These pulsations terminated in a narrow, triangular area situated posteriorly in the thoracic cavity at about the level of the angle of Ludwig. The descending portion of the aorta could not be made out definitely. The œsophagus showed no abnormalities or transmitted pulsations.

The patient died with symptoms of cerebral hemorrhage fourteen months after his first admission to the hospital. Approximately 1500 c.c. of a suspension of barium sulphate in a 0.5 per cent agar solution containing about 200 grams of sodium iodide were injected into the right common carotid artery before the necropsy was begun. Roentgenograms of the thorax were then taken in the anteroposterior and transverse diameters. Figure 2, a transverse view of the chest, clearly illustrates the site of constriction of the aorta and verifies the roentgenoscopic observations made during life. Figure 3, an anteroposterior view of the chest, shows extreme dilatation and tortuosity of the intercostal arteries. The rôle played by these vessels in the collateral circulation is strikingly demonstrated, and the cause of the extensive bilateral scalloping of the ribs is made evident.

The post-mortem findings in this patient will be reported in detail later. It is only necessary to state here that the roentgenoscopic and roentgenographic observations were fully corroborated. The external diameter of the aorta was constricted to 3.5 to 4.0 cm. for a distance of about 1.5 cm. on either side of the point of insertion of the remnants of the ductus arteriosus, whereas the diameter above this level was 7.0 cm. On opening the aorta, the

FIG. 2. Roentgenogram of the thorax after postmortem injection of the arterial vascular system with a contrast medium. Transverse view showing the site of the constriction of the aorta.

lumen of the vessel was found to be further reduced by a diaphragm of thin, yellowish tissue situated a short distance below the point of insertion of the ligamentum arteriosum. The aperture of this diaphragm measured only 1.3 by 0.5 cm. Both fifth ribs were removed and showed erosion of the inferior border and enlargement and extensive irregularity of the subcostal groove (Fig. 4). These changes were limited approximately to the posterior half of the ribs.

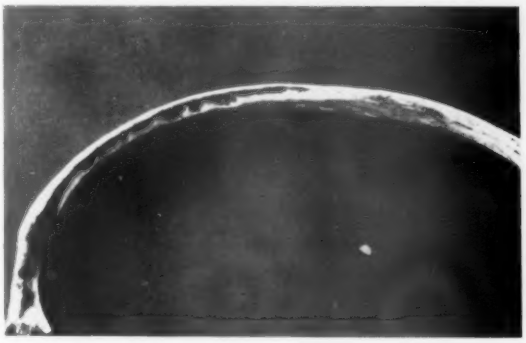

Fig. 4. Photograph of the right fifth rib showing erosion of the subcostal groove.

COMMENT

The most common causes of death in patients with coarctation of the aorta are (1) myocardial failure, (2) rupture of the aorta and (3) cerebral hemorrhage. It is important, therefore, that the presence of the anomaly be recognized as early as possible in order that the patient may be advised to avoid those occupations and situations which place undue strain on the cardiovascular system. The roentgenographic and roentgenoscopic findings in patients with coarctation of the aorta are of fundamental diagnostic importance. In some instances, the area of aortic constriction can be visualized on roentgenoscopic examination; and at times, the diagnosis may be suggested by diminution of the aortic arc on the left side with a dilated ascending aorta on the right. So far as is known, bilateral erosion of the inferior borders of the ribs occurs only in coarctation of the aorta. Routine attention to the state of the costal margins in roentgenograms of the chest, therefore, should not only enable one to confirm the diagnosis in cases recognized clinically but also detect the presence of the condition when it has been missed on physical examination.

Fig. 3. Roentgenogram of the thorax after postmortem injection of the arterial vascular system. Anteroposterior view showing the dilated, tortuous intercostal arteries.

SUMMARY

1. The clinical findings in a patient with coarctation of the aorta in whom the diagnosis was corroborated at necropsy have been presented briefly.

2. Roentgenograms of the thorax showed extensive irregular erosion of the inferior borders of the ribs bilaterally, due to prolonged pressure from the dilated, tortuous intercostal vessels taking part in the collateral circulation. This finding in the roentgenograms of the thorax is considered pathognomonic of coarctation of the aorta.

3. On roentgenoscopic examination the pulsations in the ascending portion of the aorta were seen to terminate in a narrow triangular area situated posteriorly in the thoracic cavity at about the level of the angle of Ludwig. This area corresponded to the site of stenosis of the aorta as demonstrated at necropsy.

4. Roentgenograms of the chest were taken after post-mortem injection of the arterial vascular system with a contrast medium and strikingly demonstrated both the site of the coarctation and the extreme tortuosity and dilatation of the intercostal arteries.

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RECENT ADVANCES IN RADIUM THERAPY IN BREAST CANCER*

By WILLIAM E. COSTOLOW, M.D.
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IN THE treatment of cancer of the breast, experience has shown that even the most radical forms of operative technique often fail to remove all the cancer cells. At the Radium Institute, London, from 1918 to 1928, seventy-four per cent of cases seen were recurrent following amputation of the breast. As pointed out by Handley, the limit of lymphatic permeation of malignancy cannot be determined by any clinical methods of observation. Handley showed that more than half of his recurrences took place in the supraclavicular glands or at the inner ends of the first, second, third or fourth intercostal spaces. He believed that when the cases were operated upon, the internal mammary chain of the lymphatic glands had already been infected. In other words, when breast cancer comes to operation it is already frequently an intrathoracic disease. Hence, even after radical operation Handley advises the systematic use of buried radium to destroy and prevent the intrathoracic extension of the disease.

Keynes, in his recent work with buried radium in breast carcinoma, has insisted that the areas of lymphatic drainage in breast carcinoma can be dealt with more effectively by the use of radium than by dissection, as irradiation can be carried as a routine into regions such as the parasternal and supraclavicular groups of glands, where operation usually cannot reach.

Attempts have been made for a number of years, by means of radium implanted in the tissues and large amounts of radium applied as surface packs, to destroy cancer cells beyond the possible limitation of surgical excision. At the Soiland Clinic in the past ten years we have treated a number of extensive primary and recurrent cases of carcinoma of the breast by means of radium needles buried in the tissues. We have made use of the ordinary metal radium element needles containing from 7.5 to 12.5 milligrams of radium. We usually surrounded the growth with a barrage of buried needles and often inserted needles directly into the growth. No attempt was made to implant the areas of lymphatic drainage with needles, but surface radium packs or roentgen rays were used in the treatment of these areas. A few of these patients have passed the five-year period and some are nearing the ten-year period with apparent good results. Although good results were obtained in some of the cases treated, we abandoned this method some time ago on account of the severe sloughing and necrosis which were occasionally seen. It seemed impossible with this method to devise a technique whereby an evenly distributed dosage could be applied which would be sufficient to destroy malignant process without also obtaining unnecessary reaction and later extensive telangiectasia with ulceration in some cases.

After watching for some time the reports of the work of Keynes of England, we have recently attempted to follow his technique in the treatment of a number of breast cases. Briefly, an attempt is made to extend the effect of the radium rays over a wider area than can be covered by the most extensive radical operation. As expressed by Cade, a "Radium Halsted" is performed. Platinum needles containing small amounts of radium element are introduced around the primary growth, throughout the whole breast area, along the periphery of the breast, in the axilla, in the intercostal spaces, above and below the clavicle, and along the mid-axillary line.

In our Clinic we have followed the general plan of technique described by Keynes

* Read at the Fifteenth Annual Meeting, American Radium Society, Detroit, Mich., June 23–24, 1930.

except that our needles differ somewhat in length and amount of radium content. The needles which we use contain from 1.3 to 2 milligrams of radium element and are filtered by 0.5 mm. of platinum. The needles are of two lengths, 27.7 mm. and 44 mm. Usually from 75 to 85 mg. of radium is used in a single case, distributed in 40 to 50 needles. Novocaine locally is the only anesthetic necessary. The needles are distributed as follows (Fig. 1).

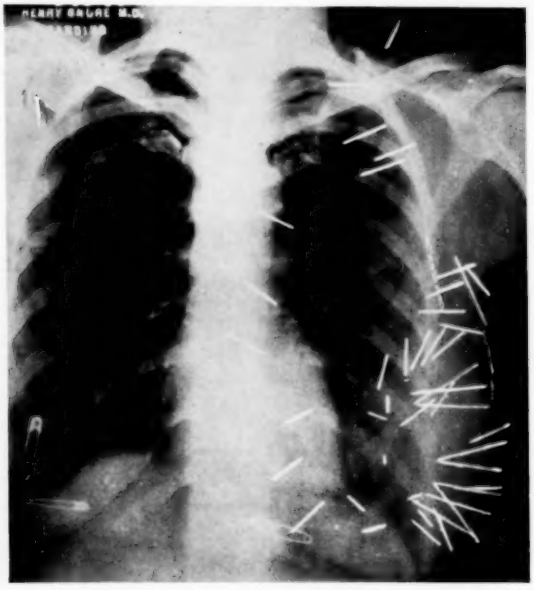

FIG. 1. Case 10579.

A. *Primary Growth and Whole Breast Area.* As pointed out by Cheatle, the whole breast area should be irradiated and not only the part containing the palpable lump. It is impossible to know how far malignant cells have disseminated in the breast. We usually surround the growth with needles 44 mm. in length, containing 2 mg. each. They are inserted 1.5 cm. apart, in a plane deep to the growth and completely surrounding it. Additional needles 27.7 mm. long and containing 2 mg. of radium are plunged 1.5 cm. apart in parallel rows, using sufficient needles to thoroughly irradiate all breast tissue.

B. *Lymphatic Drainage.* (1) A series of from 6 to 8 needles 27.7 mm. long and containing 2 mg. each are placed beneath the pectoralis major to catch the main lymph channels draining the breast.

(2) *Axilla.* Five to six needles 44 mm. long and containing 2 mg. are inserted into the axilla, distributed on its various walls. They converge towards the apex so as to form a cone of rays.

(3) *Infraclavicular Region.* Four to six needles 27.7 mm. long and containing 1.3 mg. each are inserted below the clavicle and parallel to it. These pierce the costocoracoid membrane and the pectoral muscle.

(4) *Supraclavicular Area.* Two rows of needles 27.7 mm. long and containing 1.3 mg. each are inserted above the clavicle and parallel with it. They lie deep to the cervical fascia. Four to six needles are used.

(5) *Intercostal Spaces.* Needles 27.7 mm. long and containing 2 mg. of radium are inserted in each of the four upper intercostal spaces. The points of the needles project underneath the sternum.

The dosage varies somewhat according to the extent of the pathology, but usually the needles remain in place from seven to ten days. Our average dosage has been around 15,000 milligram-hours.

Usually the local growth shows shrinkage in two or three weeks and may disappear entirely in from six weeks to two months. Keynes advises repeating the treatment if a small stationary appearing growth remains after six months. He reports improvement usually after the second application. In some cases he has excised locally a small residual fibrous mass by electrosurgical methods. In his series of 149 cases, 23 had two treatments, 3 had three treatments and 2 had four treatments. Some of these cases originally had very large growths and showed progressive improvement at each treatment until the masses completely disappeared.

RESULTS

The cases treated in our Clinic by the new interstitial technique are too recent to be of any value for statistical purposes. The immediate results, however, are very encouraging.

Table Showing Analysis of Survival Rate (Keynes)

	Operable			Inoperable		
	Cases Treated	Now Alive	Without Apparent Signs of Disease	Cases Treated	Now Alive	Without Apparent Signs of Disease
1924	—	—	—	1	1	?
1925	—	—	—	6	1	1
1926	3	1	1	3	3	3
1927	7	6	3	7	4	4
1928	29	26	13	11	5	0
1929	69	67	39	13	8	0

Keynes has recently summarized the results in 149 cases of carcinoma of the breast which he has treated since 1924 with buried radium. The total survival of 149 patients treated to the end of 1929 is as follows:

	Treated	*Alive*
Operable	108	101
Inoperable	41	22
Total	149	123

Some of these cases had excision of the local lump before irradiation and some also had roentgen treatment; 109 cases had radium only.

SUMMARY

For many years radium has been used chiefly as a palliative measure in the treatment of extensive carcinoma of the breast with wide glandular metastases. Many cases of five-year arrests have been observed and reported even in these extensive cases, for which surgery offers nothing. All who are familiar with irradiation in breast carcinoma have frequently seen extensive malignant infiltrations with axillary metastases, which have improved to the extent, after a preoperative course of surface radium applications or roentgen rays, that very little palpable pathology has remained and operation has been performed much more easily and successfully. In some of our cases, only a localized mass has remained which has been successfully removed by electrocoagulation without recurrence. We believe that the present methods of interstitial radium treatment, using small amounts of heavily filtered radium applied over a long period of time and distributed completely to all areas of lymphatic drainage, will greatly increase the number of complete arrests and the amount of palliation in extensive carcinomas of the breast.

From the work of Keynes it now appears that by complete interstitial radium treatment even the early or operable cases of breast carcinoma may show results sufficiently encouraging to warrant a more general adoption of this method. Keynes states: "I am persuaded that, in early cases, radium is the treatment of choice. The tumor disappears within a few weeks, the tissues usually become normal, and, so far, in no early cases has recurrence taken place. The patient is unmutilated, and may even be able to use the breast for normal lactation."*

* For discussion, see page 253.

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RADIUM TREATMENT OF CANCER OF THE BREAST*

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IN THE order of frequency of malignant tumors of the body, the breast stands third, and of all the tumors affecting the breast, 85 per cent are carcinomas.

With the constant improvement in surgical technique brought about by the advances in our knowledge of proper surgical care and procedures, the primary mortality from operation in carcinoma of the breast has been reduced considerably.

It was only, however, with the advent of radiation therapy following the discovery of x-rays and radium that a new hope sprang up for the complete cure of cancer by physical methods without the employment of surgery. This early enthusiasm proved short-lived, and as a result, radiation was for a time in disfavor. With increased knowledge of the properties and character of roentgen rays and radium and better understanding of their physical and biological action, the treatment of breast conditions by radiation was resumed, but by radiologists who had been taught by their experiences to forego the earlier too enthusiastic hopes of a complete cure. In only a few instances, however, was radiation alone relied upon in caring for these conditions; in most cases it was used in conjunction with surgery. Because surgery offers so excellent a method of treatment in cases of early localized carcinoma of the breast, only such conditions as were considered beyond surgical interference were turned over to the radiotherapist.

It was in the hope of doing something for these apparently hopeless, abandoned cases that we sought in 1924 to offer some other means of treating breast carcinomas.

For some time Regaud, at the Curie Institute in Paris, has been advancing the theory of the selectivity of the gamma rays for carcinoma cells. He claimed that only the short, penetrating, gamma rays give the therapeutic results necessary to properly control the lesion treated, and that in order to produce these rays a suitable means of filtering radium was required. Such a means he found in the use of platinum as a filter medium, and it was then deemed necessary only to direct these selective rays in certain quantities and proportions through an involved area in order to control the condition. Unfortunately, while such procedure is physically possible in the treatment of a single, localized lesion, it is out of the question in most of the cases received by the radiologist. For carcinoma is a growth which knows no regulation and all too soon becomes a generalized condition spreading beyond the local area and throughout the body. In breast conditions, particularly, is this the case, for with the increased knowl-

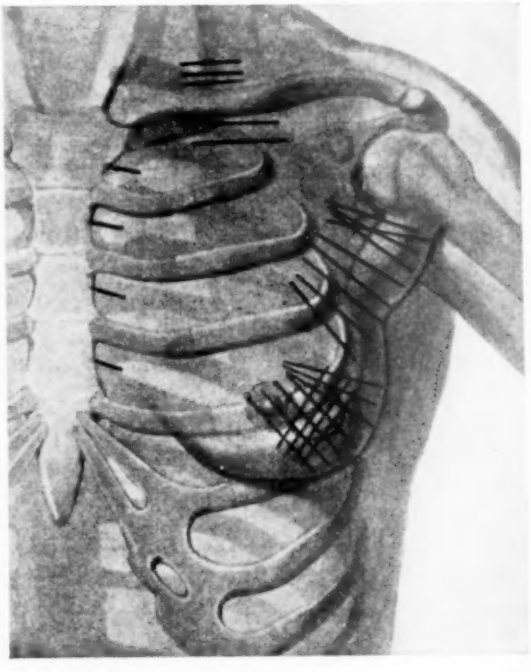

FIG. 1. Diagram showing Keynes, method of radium implantation (from Keynes).

* Read at the Fifteenth Annual Meeting, American Radium Society, Detroit, Mich., June 23–24, 1930.

edge of the anatomy and pathology of the breast we have learned that the lymphatic drainage of the breast is the important factor in the care of carcinoma situated there.

Fig. 2. Radium needles in place, showing iodoform gauze dressing.

Already in 1878 Halsted had emphasized the extension of carcinoma cells through the lymphatics and advised wide dissection of the whole chest area, while Sampson Handley going still further, advocated even a more radical removal of all the tissues bordering on an involved carcinomatous breast, basing his procedure on the theory of centrifugal permeation of cancer cells through all the surrounding tissues. In all proper surgical procedures a rather extensive denuding operation is required, and while the operative mortality has not been high, the ultimate results in cures have not been any too good, despite the fact that the utmost skill is exercised. Recurrences have been frequent and metastases have placed the patient in a worse state than before operation. In fact, one often comes to feel that the spread of these carcinoma cells throughout the body has been due to opening the paths of dissemination by the surgical procedures used in the case.

For these reasons, therefore, we at Bellevue Hospital believed that radiation might be used equally as well as surgery in the care of cases of carcinoma of the breast. The first cases referred to us for irradiation alone were frankly inoperable and hopeless—two patients with long-standing ulcerated breasts with definite metastasis to the axilla and perhaps throughout the body, as evidenced by vague rheumatic pains, though not localized on the roentgen examination of the skeleton. Following a general treatment with high voltage roentgen rays, radium therapy by the radium puncture method was given, platinum filtered needles of radium emanation being inserted around the periphery of the lesions. A marked reaction followed the irradiation and the lesions showed regression. Unfortunately, both patients failed to return to the clinic after two months, and were not again located, so that the final results of the treatment are unknown.

Surgeons were loath to hand over for ir-

Fig. 3. Radium needles in place surrounding the lesion.

Fig. 4. Roentgenogram of chest showing radium needles in place around lesion.

radiation any cases they deemed still operable until this year when with the cooperation of Dr. Wadhams of the Third Surgical Division of Bellevue, we were given an opportunity again to treat operable breast cases with radium.

The question of diagnosis of the lesion being treated is important, and ordinarily we do not deem it harmful to take a biopsy in certain malignant conditions, for example, those in the mouth, skin and cervix. But in the breast, such procedures are not so simply carried out, and besides, the usual case presenting itself for treatment has unmistakable clinical evidences of malignancy, such as metastatic nodes and local or diffuse involvement of the surrounding tissues or distant organs. Under such circumstances, we do not think it advisable to increase the hazard by incising a carcinomatous breast for biopsy purposes. Outside of exceptional cases, we rely on the clinical diagnosis which from experience we have found to be sufficiently accurate not to cause harm to the patient should our diagnosis prove later to be erroneous. Therefore, in most of the cases treated, diagnosis has been made on the basis of clinical evidence of malignancy.

Keynes of London reported in February, 1930, the results of interstitial irradiation of primary carcinoma of the breast in 154 cases, the first being done in August, 1924. His method as practised in St. Bartholomew's Hospital, London, is to use about 35 long platinum needles of 0.6 mm. wall filtration, and some of them 4.8 cm. in length, containing 3 mg. of radium element, and others 3 cm. long containing 2 mg. of radium. These he distributes so that the primary growth and the lymphatic drainage areas are effectively irradiated. The needles are placed: (1) beneath the breast itself; (2) beneath the pectoral muscles; (3) in the axilla; (4) on the costocoracoid membrane; (5) above the clavicle, and (6) in the upper three or four intercostal spaces. The needles are left in place for five to seven days, in accordance with the Regaud technique, which is to apply a small amount of radium over a long period of time in the treatment of carcinoma.

In our radium work at Bellevue Hospital we have followed the Regaud technique, using small amounts of radium applied over a long period of time, in heavily filtered tubes or needles. In the treatment of breast cases we have used platinum needles of 0.4

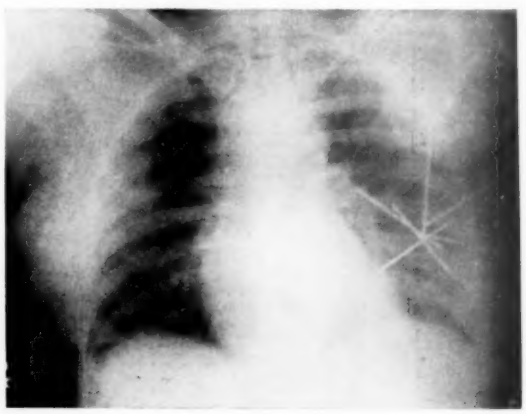

Fig. 5. Cancer of breast showing long radium needles in place under the tumor mass; needles of platinum 0.6 mm. wall filtration and containing 3 mg. of radium element each.

mm. filtration of 35 mm. length and containing 2 mg. of radium each. The needles are inserted in and around the periphery of the tumor and around such palpable metastatic nodes as are present. To give the dosage required, needles are left in place five to seven days, depending on the size of the area involved. The operation is done under local anesthesia and the patient suffers very little discomfort from the radium while it is in place.

At the Cancer Clinic—a department in the Division of Cancer—Keynes' method has been followed quite closely. Gold needles encased in a thin, steel jacket, making a wall filtration equivalent to 0.5 mm. platinum are used. The needles are of three lengths: 9, 3.7, and 2.7 cm., and are filled for use with radium emanation of 1 millicurie per centimeter length. In the treatment the large needles are inserted around and beneath the breast tumor and in the axilla. The smaller ones are placed in the supraclavicular and infraclavicular areas. The needles are left in place from five to eight days. Sometimes a second treatment is given in six to eight weeks after the first should the mass still persist.

It is too soon to report definite results but judging from the cases already treated, the results are very encouraging. At any rate, this method of treatment has the great advantage of eliminating the inevitable mutilation attendant upon a radical breast operation, and it does not increase the risk of further cancerous extension beyond what existed in the patient at the time treatment was given.

Figures 1, 2, 3, 4 and 5 show the type of cases treated, and the distribution of the radium needles in situ, describing graphically the method we are employing.

DISCUSSION ON PAPERS OF COSTOLOW AND KAPLAN

Dr. Burton J. Lee, New York City. These two papers have been very interesting indeed. Carcinoma of the breast is a large problem from the standpoint of irradiation. I believe in our thought on the subject we have to keep in mind that a lesion in the breast is comparatively simple to handle, but in the axilla and the outlying areas it is quite a different matter. If we could confine the tumor to the breast I think we could be quite sure that it could be handled by irradiation measures. If you visualize the axilla and its association with the nodes lying along the pectoralis major and along the veins up to the summit of the axilla, you will realize that you have an area into which it is very difficult to introduce radium effectively.

The irradiation gives a large percentage of gamma radiation, about 85 per cent, and we still have about 15 per cent of beta radiation remaining. In 1919 Dr. Quick treated a patient at the Memorial Hospital with bare seeds. No biopsy was taken, but up to the present time that patient has remained well, eleven years. Up to the present we have treated several cases that have gone over five years, and the irradiation results compare favorably with those cases in which surgery has been used.

At the Memorial Hospital we are using a method which I think is perhaps not so good as the method proposed by Dr. Keynes of London, and followed by Dr. Kaplan and Dr. Costolow. We have followed a careful plotting of the tumor so that we might introduce at any time a dose similar to that used in a given case in the beginning. We feel that we must give a tissue dosage into the tumor which will be delivered by 10 to 12 doses.

The cases operable we divide into three groups. In the first we use no radiation at all, following Dr. Greenough's suggestion to check up on results. In the second group we give exact radiation therapy, followed by gold seed implantation into the tumor in a capsule, and four or five weeks later a radical amputation is done. In the third group we use only the gold seed implantation, with dissection four or five weeks later.

I have had many conversations with Dr. Ewing and his proposition was that when we had 100 cases treated in this way in which we knew the irradiation and all the findings, we might then go ahead and add a fourth group, treated with irradiation alone. We propose to do this this fall.

In keeping all these things in mind, I think we may assume that in well chosen cases, in well operated clinics, the operable group is approximately 35 per cent, taking cases as they

run. Two or three years ago we checked up our operated cases with the irradiated cases and found that the figures were approximately the same. I think we cannot discard surgery without considerable mature thought. If you grade your cases, which should be done in this field by histological or clinical methods, you will find that in Grade A cases, 69 per cent are alive at the end of five years; in Grade B there will be 34 per cent alive, and in Grade C 4 per cent will be alive. We must, I think, keep in mind that carcinoma of the breast represents a group of diseases. In one type it is highly malignant and the whole story will be ended in a few months. In another type, particularly in older women, it drags along for years and years. The end-results in these cases are very different than in the young women. We have surveyed our cases of young women treated by radical amputation and at the end of three years we had 6 per cent only of 306 cases. At the end of nine years there was 3 per cent only. These young women are, I think, poor cases for surgery. I think there we have to start upon an irradiation program which is sound, intelligent, and based on sound judgment. I am very enthusiastic about this method, and think much is to be expected from it. If we choose our cases carefully and in our reports give the grade of the case, I think we will all learn much within the next few years.

As to placing radium in the intercostal space, I have never been in favor of this, but may change my opinion. Not all the spread is by direct extension through the tissue. I think the method of using needles in the supraclavicular fossae, as proposed, is excellent. The nodes are accessible.

I think some method should be supplied for careful plotting out of the axillary space, endeavoring to visualize to the radium operator just what is there. You may palpate an axilla and feel no nodes, but they may be there just the same. Some of the worst cases are the small, pinhead nodes which may not be discovered at all by palpation.

I believe the main problem, as I see it, is to properly visualize the axillary space and be sure that you get into that area 10 or 12 erythema doses, whether by platinum needles or gold seeds I think is immaterial.

DR. WILLIAM NEILL, JR., Baltimore, Md. Carcinoma of the breast is a very difficult condition to cure by any method. It is a question, particularly in the old patients with scirrhous carcinoma, whether or not to interfere. Unless ulceration is present, I really think they will live longer if they are left undisturbed.

My figures are not so optimistic as Dr. Lee's, for we have found that by operation in the very early cases, where no involved glands are encountered in the axilla, we can expect only 50 per cent to be alive after five years. Where there are one or two small glands, 70 per cent will end fatally before five years, and if there are massive glands, we cannot expect 5 per cent.

Surgery is apparently being used less and less in England. I advise postoperative irradiation in every case, and the treatment is intense surface application to the skin, and massive distance irradiation for the neck and axilla. For the inoperable ones, the surface irradiation is the same plus the implantation of emanation or radon within the glands. This is enclosed in gold inserted with a string attached so it can be removed after the desired dosage is given. We put in each of these capsules as high as 20 to 30 mc.

In our experience carcinoma of the breast tends to metastasize to the lungs and bones, and treatment after the lungs are involved should be simple irradiation for pain. I have seen almost the entire skeleton involved in carcinoma of the breast, and where vague rheumatic pains are encountered we should be suspicious of bone involvement.

DR. KAPLAN (closing). There is one point about carcinoma of the lung, metastatic from breast carcinoma. Every case treated in our department is thoroughly x-rayed for breast involvement. Every case in the surgical department is also roentgenographed for metastatic lesions, as well as for other pulmonic involvement.

I have spoken only of those cases which we treated with radium. The surgical section operates only on cases that have been preoperatively irradiated. This would cover the cases Dr. Lee mentioned of the young women who come in with breast tumor, with rapidly fatal result. We try to prevent that result by irradiation. We felt that one reason we could not follow Keynes' plan of inserting needles in the axilla at random was because we have not been able to feel definite lesions in many cases where there was involvement of the axilla. Dr. Quick's idea of opening the neck and searching for glands might be carried out in the axilla, but it is more difficult to dissect the axilla than the neck.

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STUDIES OF THE SYSTEMIC EFFECT OF ROENTGEN RAYS

II. THE ACID-BASE BALANCE AND THE SERUM PROTEINS OF DOGS BEFORE AND AFTER IRRADIATION

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AMONG the numerous investigations of the more essential biochemical changes resulting from irradiation, observations as to alterations in the acid-base balance have been comparatively few and more or less contradictory. Lange,[20] observing that roentgen sickness was relieved by administration of bicarbonate, brought forward the hypothesis that the constitutional manifestations are secondary to an acidosis consequent to the roentgen-ray exposure. Lange's theory was experimentally substantiated by Denis, Martin, and Aldrich[7] who showed that when rabbits were exposed over the abdominal region to lethal doses of roentgen rays, the alkali reserve of the blood was lowered. This reduction of alkali reserve, however, did not occur until several days after irradiation and the greatest decrease was evident shortly before the death of the animal. Identical dosage over the chest or legs with the abdomen protected was not fatal and did not influence the alkali reserve. In the irradiated dogs of Hall and Whipple,[13] the chief deviation from the normal was a disturbance of the hydrogen ion concentration and sometimes a slight lowering of the alkali reserve. Twenty-four hours after treatment, the hydrogen ion concentration was diminished and the alkali reserve was increased. Hirsch and Petersen[16] observed a disturbance of the acid-base equilibrium, with an occasional small decrease of the alkali reserve, immediately after treatment. Gigon[9] has affirmed that repeated investigations of the alterations of the blood *p*H show, in healthy men and animals, a fall in *p*H after irradiation.

Evidence practically refuting the theory of acidosis has also been presented. Case[4] found all tests for acidosis negative in his clinic. Golden,[11] since neither patients nor dogs under his observation exhibited any lowered alkali reserve, concluded that acidosis was not associated with irradiation. Hussey,[18] investigating this theory, noted instead of the expected acidosis an uncompensated alkali excess. Konrich and Scheller[19] reported a constant fall of the *p*H of rabbits' blood one hour after exposure. Cluzet and Kofman[5] recorded a shifting of blood *p*H to the alkaline side when rabbits were irradiated over the splenic region.

In view of the findings of certain other workers, it would seem that the above apparently contradictory reports may not be so paradoxical as they at first appear. Doub, Bolliger, and Hartman[8] stated that a moderate dosage of roentgen rays results in an early alkalosis, probably due to the liberation of purine bases from the destroyed nuclear material. From the alkalosis stage there is a prompt return to normal, followed by a mild compensating acidosis within twenty-four hours. Very heavy dosage results in a gradually increasing alkalosis with fatal termination. These authors interpreted the acidosis as a protective mechanism against the subsequently occurring alkalosis. von Pannewitz[24] observed that the estimation of blood *p*H and CO_2, both in men and rabbits, revealed a bi-phasic reaction incident to irradiation, a short period of acidosis followed by a longer period of alkalosis. He reported a marked acidosis after exposure in the region of the liver, and this acidosis was not followed by the alkalosis phase. Since von Pannewitz' experiments on blood in vitro invariably showed an increase of the hydrogen ion concentration after irradiation of the blood

samples, he looked upon the acidotic phase in vivo as the direct effect of the roentgen rays, the alkalotic phase as the result of the liberation of cleavage products into the blood stream. It would perhaps be possible to reconcile these varied and seemingly opposed findings were consideration given to the matter of time of making the observations after exposure.

The effects of radiation upon the blood proteins early received the attention of investigators who based their work upon the tentative theory that the toxicity might be due to the products of proteolytic or autolytic, perhaps anaphylactic, changes. The significance of alterations in the serum albumin and serum globulin consequent to irradiation has only recently been considered and the data are as yet quite limited. Herzfeld and Schinz[15] have reported the results of 36 serum albumin determinations made before and after irradiation. Immediately after exposure 29 of these showed a decrease, 6 an increase, and one no change in the serum albumin. Wichels and Behrens,[28] investigating the influence of roentgen rays on the albuminous substances of the blood, found that the normal total protein content of blood serum is not altered after irradiation according to any rule. In general a decrease is noted. Abnormally high values gradually reach the normal. The albumin-globulin ratio, however, does show a definitely regular shifting, which may be sharply divided into two types of reaction. Normal individuals react with an albuminemia, while allergic persons react with a globulinemia. If at the height of the reaction after irradiation the subject is again exposed, the response is just the reverse of that exhibited after the first exposure. If the second stimulus is imposed immediately after the first, the reaction is unchanged. These authors concluded that the results were dependent not only upon the dosage employed but also upon the condition of the organism at the time of irradiation; that is, upon the readiness of the organism to respond. They hold that the shifting of the albumin-globulin ratio is incited by an increased delivery of albumin to the blood. Breitlander and Lasch[3] have reported that no appreciable alteration of the serum proteins in patients results from roentgen-ray exposure.

This brief review demonstrates the number and variety of contradictory conclusions concerning the effect of roentgen rays upon the acid-base balance and upon the protein constituents, the albumin-globulin content and ratio, of the blood. Wichels and Behrens, Rolleston,[26] and others, have expressed the opinion that roentgen rays as a form of energy do exert a profound effect upon metabolism and that undoubtedly the response of the individual depends both upon dosage and the condition of the organism. The effects are most marked in persons already in a toxic condition. Such patients are burdened in dealing with the intoxication, and if to this strain is added the further metabolic labor of handling a large amount of decomposed tissue products, the metabolism may break beneath the load. In view of such a premise it would seem that the question of the systemic effect of irradiation can be satisfactorily answered only by extensive investigation of its effect upon the normal individual. Conducting such experiments upon a large scale with human beings as subjects is of course not feasible. It therefore seemed to us not untimely to extend further the scope of animal investigation in this field and for the present we have chosen to carry on a series of studies of the acid-base balance and the albumin-globulin content and ratio of normal dogs' blood before and after exposure to accurately measured doses of roentgen rays.

METHODS

The general conduct of the experiments and the experimental conditions were as described in a former publication;[25] the feeding and housing of the dogs were the same, blood samples and hemoglobin readings were taken at the same intervals after irradiation, and the site of exposure and the dosage of roentgen rays were identical.

The blood, 20 c.c., was withdrawn from the femoral vein directly under oil into a centrifuge tube in which it was centrifuged at high speed for fifteen minutes. The serum was retained in this tube under oil to prevent loss of CO_2 until the gasometric determinations were completed.

Both electrometric and colorimetric estimations of *p*H were made on serum from each blood sample. The McClendon hydrogen electrode was used for the electrometric determinations. For the colorimetric estimations the Hastings type of hydrogen ion colorimeter was employed and the technique of Hastings[14] followed. All *p*H determinations were made at a temperature of 25°C. They were always completed one-half hour after taking the blood. To determine the CO_2 combining power of the serum, Van Slyke's gasometric method[27] was used. These estimations were always made within one hour of the withdrawal of the blood from the vein.

After comparing several methods for determining the albumin and globulin content of serum, the colorimetric method recently developed by Greenberg[12] was found less cumbersome, more rapid, and quite as accurate as other familiar methods and was therefore selected for these experiments.

The results of the investigations are compiled in Tables I, II, III, IV and V.

DISCUSSION

In none of the dogs did the hemoglobin content show any significant changes; hence it may be concluded that any variations observed must be ascribed to causes other than alterations in blood concentration due to the bleeding.

Table I is presented as a summary of the results of 45 analyses of the blood sera of 9 normal dogs with respect to the constituents under investigation in this work. The observations covered periods of from two to eight weeks, during which blood samples were taken at varied intervals with the two-fold purpose of ascertaining how much individual variation might occur within a few hours, from day to day, or over longer periods of time, and of securing information as to the normal range for the species. Consideration of the findings as to the serum proteins leads to agreement with Matthew[23] that these constituents of the blood of normal dogs remain fairly constant in any one animal over long periods. There also is concurrence with this investigator as to the average albumin content. Matthew found an average of 4.64 per cent albumin in the plasma. The serum albumin here recorded is 4.18 per cent average. The animals of this series, however, exhibited a lower minimum and a lower maximum of serum albumin content than did the normal dogs of Matthew; the latter noted plasma albumin range of but 4.13 to 5.57 per cent. The divergence from this investigator is more marked with regard to the globulin content. The average serum globulin content of this group of dogs is 1.33 per cent, with extremes of 1.00 and 1.92 per cent, while the plasma content, according to Matthew averages 2.12 per cent of globulin, with extremes of 1.70 and 2.90 per cent. A limited number of experiments comparing the Greenberg with the Wu method, which is that used by Matthew, demonstrated close agreement between the two methods when applied to determinations of serum albumin and globulin. The ratio of albumin to globulin in these normal dogs falls within the limits established by Greenberg for human sera.

The data relative to the acid-base equilibrium show a rather greater individual variation in this group of dogs than is ordinarily encountered in normal human beings. Although the analyses were made only upon samples of blood obtained without struggle or evident opposition on the part of the animal, it is noted that the greatest constancy in *p*H appears in dog number 9, which at no time seemed apprehensive toward the proceedings incident to taking of the blood samples. Despite a rather large body of opinion against the employment of colorimetric methods for determining the *p*H of dogs' blood, these experiments show remarkable agreement

TABLE I.

RESULTS OF REPEATED DETERMINATIONS ON SERA OF NORMAL DOGS

Dog	Time*	Albumin per cent	Globulin per cent	Albumin / Globulin Ratio	*p*H Elect.	*p*H Color.	CO_2 combining power of serum c.c. per cent.
1	0	3.70	1.60	2.31	7.31	7.30	50.9
1	1 wk.	3.48	1.50	2.26	7.34	7.34	51.3
1	2 wks.	3.33	1.60	2.08	7.50	7.47	49.3
2	0	3.74	1.40	2.29	7.40	7.38	50.7
2	1 wk.	3.20	1.50	2.13	7.50	7.47	49.0
2	2 wks.	2.88	1.88	1.53	7.50	7.49	55.0
3**	0	3.74	1.00	3.74	7.36	7.36	45.0
3	1 wk.	3.45	1.03	3.35	7.40	7.42	47.2
3	2 wks.	4.02	1.33	3.02	7.34	7.35	50.4
3	6 hrs.	4.12	1.30	3.77	7.38	7.36	50.9
3	24 hrs.	4.18	1.30	3.21	7.35	7.36	51.3
3	48 hrs.	3.99	1.30	3.07	7.35	7.34	50.3
3	5 days	3.45	1.07	3.22	7.31	7.34	50.4
3	3 wks.	3.28	1.08	3.04	7.36	7.36	58.0
3	2 wks.	3.30	1.03	3.20	7.38	7.36	57.8
4	0	3.87	1.47	2.63	7.35	7.36	59.5
4	1 wk.	3.78	1.37	2.76	7.47	7.48	60.6
4	2 wks.	3.22	1.42	2.27	7.31	7.31	58.9
5	0	3.00	1.92	1.56	7.26	7.26	60.7
5	1 wk.	3.05	1.82	1.67	7.35	7.34	55.2
5	2 wks.	3.00	1.97	1.52	7.35	7.35	52.2
6**	0	3.61	1.00	3.61	7.26	7.28	48.5
6	1 wk.	3.71	1.03	3.60	7.31	7.31	47.6
6	2 wks.	3.66	1.22	3.00	7.35	7.34	48.1
6	6 hrs.	3.61	1.22	2.95	7.38	7.36	50.0
6	24 hrs.	3.61	1.24	2.91	7.36	7.34	48.1
6	48 hrs.	3.62	1.25	2.90	7.35	7.35	51.3
6	5 days	3.70	1.26	2.94	7.35	7.36	50.2
6	3 wks.	3.28	1.16	2.82	7.35	7.34	56.0
6	2 wks.	3.02	1.02	2.96	7.36	7.35	63.0
A	0	3.22	1.20	2.68	7.44	7.42	58.9
A	1 wk.	3.03	1.23	2.46	7.45	7.46	61.7
A	2 wks.	3.11	1.25	2.49	7.44	7.45	61.0
B	0	3.70	1.26	2.94	7.35	7.36	50.2
B	1 wk.	3.28	1.16	2.82	7.35	7.34	56.0
B	2 wks.	3.02	1.02	2.96	7.36	7.35	63.3
9**	0	3.83	1.67	2.29	7.31	7.32	59.8
9	1 wk.	3.90	1.81	2.15	7.30	7.32	53.8
9	2 wks.	3.33	1.60	2.08	7.31	7.32	59.8
9	6 hrs.	2.87	1.34	2.14	7.34	7.32	56.0
9	24 hrs.	2.98	1.34	2.22	7.36	7.36	61.0
9	48 hrs	2.94	1.30	2.26	7.34	7.35	59.0
9	5 days	3.04	1.51	2.01	7.36	7.38	57.0
9	3 wks.	3.20	1.50	2.13	7.35	7.35	57.6
9	2 wks.	3.15	1.49	2.11	7.37	7.35	58.2
Average		3.43	1.33	2.85	7.38	7.36	54.4
Maximum		4.18	1.92	3.77	7.50	7.49	61.7
Minimum		2.70	1.00	1.52	7.26	7.28	48.1

* Time interval since taking of last blood sample.

** Dogs 3, 6, and 9 were observed over a period of eight weeks.

between the electrometric and the colorimetric methods as used in these analyses. The inconstancy of the correction factor noted by Cullen and coworkers[6] as essential to the reduction of the colorimetric *p*H of dogs' sera and plasma to values comparable with the electrometric *p*H is not manifest in this series. This may possibly be due to the superiority of the colorimeter over the test tube method with respect to ease and accuracy in matching colors. The CO_2 combining power of normal dog sera, in accord with the opinion of Golden,[11] is seen to be somewhat lower than that recorded by Hjort and Taylor,[17] who found the plasma CO_2 capacity of apparently normal dogs to vary from 42.9 to 67.3 volumes per cent. In the forty-five estimations here recorded the extreme limits are 48.1 and 61.7 volumes per cent. There is some variation to be noted in individual animals; some show a fairly constant level throughout the period of observation, the differences between successive findings being not greater than 2, 6, and 8 volumes per cent. Others of this group exhibit a variation of as much as 13 and 16 volumes per cent from previous or succeeding findings in the same animal.

Table II summarizes the experiments investigating the effect of roentgen rays on the acid-base balance of normal dogs. The 6 dogs receiving treatment do not show any marked or consistent variations from the pre-treatment levels of *p*H and CO_2 combining power of serum. A comparison of the figures recorded for the treated animals with those of the normal control animals of each group or with the figures of Table I, shows that the fluctuations of *p*H and CO_2 in the exposed animals remain well within the limits established for normal dogs. It is also to be observed that neither site of exposure nor dose has any specific influence upon the acid-base equilibrium. Dogs irradiated over the abdomen respond quite the same as dogs irradiated over the chest. Although the animals of Group III received twice the dose given to the treated dogs of the other two groups, the *p*H and CO_2 capacity continued within physiological lim-

Table II

Acid-Base Balance in Normal Dogs before and after Irradiation

Group	Dog	Weight (kilos)	*p*H of Serum								CO_2 Combining Power of Serum (Volumes per cent)								Remarks
			Pre-treatment			Post-treatment					Pre-treatment			Post-treatment					
			2 wks.	1 wk.	6 hrs.	20 min.	24 hrs.	48 hrs.	1 wk.	4 wks.	6 wks.	2 wks.	1 wk.	6 hrs.	20 min.	24 hrs.	48 hrs.	1 wk.	4 wks.	6 wks.	
			Elec.	Elec.	Elec.	Elec.	Elec.	Elec.	Elec.	Elec.	Elec.										
I	1	6	7.31	7.34	7.50	7.75	7.36	7.34	7.50	7.31	7.30	50.9	51.3	49.3	56.0	51.1	49.4	54.3	59.8	53.8	500 r (air value); 600 r surface dose; over posterior lower body. (160–180 kv., 25 mm. Cu—1.0 mm. Al, 50 cm. focus skin distance.
	2	9	7.40	7.50	7.50	7.25	7.35	7.30	7.30	7.35	7.42	50.7	49.0	55.0	60.5	54.0	58.9	49.4	59.5	51.3	
	3*	11	7.36	7.40	7.34	7.38	7.35	7.35	7.31	7.36	7.38	45.0	47.2	50.3	50.9	51.3	50.4	50.7	58.0	57.8	
II	4	7.2	7.35	7.48	7.31	7.40	7.35	7.35	7.43	7.30	7.34	59.5	60.6	58.9	58.7	59.7	60.7	57.9	56.0	57.9	500r (air value) over posterior chest.
	5	6.9	7.26	7.35	7.35	7.35	7.38	7.44	7.35	7.40	7.40	60.7	55.2	52.2	60.7	62.4	56.0	58.9	59.4	57.3	
	6*	9.0	7.26	7.31	7.35	7.38	7.36	7.35	7.35	7.35	7.36	48.5	47.6	48.1	50.0	48.1	51.3	50.2	56.0	63.0	
III	A	10.5	7.44	7.45	7.44	7.40	7.37	7.45	7.44	7.45	7.45	58.9	50.4	49.0	61.0	59.8	58.0	57.0	54.8	59.6	500 r (air value) over anterior and posterior lower body.
	B	9.0	7.35	7.35	7.36	7.35	7.40	7.36	7.37	7.38	7.37	50.2	60.6	56.6	63.6	61.7	60.5	62.4	59.4	60.1	
	9*	7.0	7.31	7.30	7.31	7.34	7.42	7.34	7.36	7.35	7.37	59.8	53.8	59.8	56.0	61.0	59.0	57.9	58.2	57.6	

* Untreated control dogs.

its. If one considers the treated animals as a whole there is a suggestion of a slight shift of the CO_2 combining power toward the alkaline side immediately after treatment in 4 of the irradiated dogs. Rise in CO_2 capacity does not occur in either of the 2 dogs subjected to double exposure. It is quite possible that there was a transient alkalosis in the dogs of Groups I and II due to over ventilation as a consequence of the quite generally observed restlessness and some struggling of these dogs during treatment, while the dogs subjected to longer exposure became quiet and slept during the second half of the treatment period.

Comparison of the results obtained by the colorimetric and the electrometric methods for determining the *p*H of serum at room temperature again shows very close agreement between the two methods, as indicated by the fact that 23.5 per cent of the colorimetric values were the same as the electrometric values, 44.4 per cent within ±0.01 *p*H, 30.0 per cent within ±0.02 *p*H, and 2.00 per cent within ±0.03 *p*H of the electrometric value. This leads to the conclusion that, with observance of proper precautions, the colorimetric method using the Hastings type of hydrogen ion colorimeter is reliable for such comparative studies of the *p*H of dog serum.

Tables III and IV present a summary of the studies as to the effect of roentgen rays on the serum proteins. These figures show a regular though slight alteration in the serum albumin consequent to irradiation. The irradiated animals all manifest a diminution of the serum albumin within forty-eight hours of the exposure. With the exception of dog 2 there is an immediate decrease in serum albumin and in most cases a continued sinking throughout forty-eight hours after treatment. The effects of irradiation on dog number 2 are difficult to assess since this animal exhibited an unaccountable drop in serum albumin six hours before treatment. The rise noted immediately after exposure, therefore, cannot be attributed solely to the roentgen-ray effect. The response of the serum albumin in this animal was quite in accord with that of the other irradiated dogs at the twenty-four and forty-eight hour observations; the serum albumin was decreased at twenty-four hours and continued to diminish through forty-eight hours after the treatment. The fluctuations of the serum globulin appear less uniform. The dogs of Groups I and II, subjected to identical dosage though over different parts of the body—Group I over the lower body and Group II over the chest—closely resemble each other in the order of change in serum globulin content. There is an immediate decrease followed by an in-

TABLE III

ALBUMIN AND GLOBULIN OF DOG SERA BEFORE AND AFTER IRRADIATION

Group	Dog	Weight kilos	Serum Albumin per cent									Serum Globulin per cent								
			Pre-treatment				Post-treatment					Pre-treatment				Post-treatment				
			2 wk.	1 wk.	6 hrs.	20 min.	24 hrs.	48 hrs.	1 wk.	4 wks.	6 wk.	2 wks.	1 wk.	6 hrs.	20 min.	24 hrs.	48 hrs.	1 wk.	4 wks.	6 wks.
I	1	6	3.70	3.48	3.33	2.87	2.98	2.24	3.84	3.83	3.90	1.60	1.34	1.74	1.12	1.81	1.12	1.81	1.67	1.81
	2	9	3.20	3.20	2.88	3.49	2.89	2.71	3.40	3.28	3.19	1.40	1.50	1.88	1.45	1.66	1.31	1.52	1.41	1.43
	3*	11	3.74	3.45	4.02	4.12	4.18	3.99	3.45	3.28	3.30	1.00	1.03	1.33	1.30	1.30	1.30	1.07	1.08	1.03
II	4	7.2	3.87	3.78	3.22	2.92	3.30	3.22	3.80	3.12	3.80	1.47	1.37	1.42	1.10	1.43	1.23	1.43	1.32	1.37
	5	6.9	3.00	3.05	3.00	2.92	2.65	2.83	3.12	3.26	3.24	1.92	1.82	1.97	2.11	2.05	1.88	1.98	2.19	2.22
	6*	9.0	3.61	3.61	3.62	3.70	3.28	3.02	3.70	3.28	3.02	1.00	1.03	1.22	1.24	1.25	1.25	1.26	1.16	1.02
III	A	10.5	3.22	3.03	3.11	2.88	3.24	3.22	3.24	3.22	3.27	1.20	1.23	1.25	2.21	1.87	1.80	1.21	1.22	1.18
	B	9.0	3.70	3.28	3.02	2.86	2.70	3.00	3.38	3.30	3.40	1.26	1.16	1.02	1.22	1.11	1.11	1.39	1.25	1.22
	9*	7.0	3.83	3.90	3.33	2.87	2.98	2.94	3.04	3.20	3.15	1.67	1.81	1.60	1.34	1.51	1.30	1.51	1.50	1.49

* Untreated control dogs.

crease which, twenty-four hours after treatment, reaches a level higher than that of the pre-treatment period. At the forty-eight hour observation the globulin of the serum has in all cases begun to fall. The dogs of Group III, exposed to twice the dose, responded with an immediate increase over the pre-treatment level of serum globulin. In neither of these two dogs is the globulin rise sustained until the forty-eight hour observation. The changes of the albumin-globulin ratio are not outstanding since the fall of the two factors is frequently simultaneous and the magnitude of drop in each such as to alter the quotient but little. The most general change is a slightly lowered ratio coincident with a rise in serum globulin together with a more or less marked decrease of serum albumin. Dog A, of the group subjected to double exposure, differs from the other treated animals in that the most marked drop in the albumin-globulin quotient occurs immediately after treatment. In this dog the index remains low throughout the forty-eight hours after treatment while in the other treated dogs the ratio either remains close to the pre-treatment limits or returns to that level within forty-eight hours. In all the treated dogs both the serum albumin and serum globulin appear to be at normal levels one week after exposure and remain at a fairly constant level throughout the remainder of the observation period.

These studies of the albumin-globulin fluctuations of the serum of dogs' blood support the observations of Herzfeld and Schinz[15] who found that in man irradiation causes changes in the serum proteins, with a relative increase of the globulin fraction. Löhr's[22] suggestion that the destruction of serum proteins is an important result of roentgen-ray exposure seems borne out by the immediate decrease in both serum albumin and globulin noted in the majority of the animals of this series. The fact that the globulin returns to the pre-treatment level or above within twenty-four hours may possibly be explained as due to a pouring into the blood stream of an excess of globulin the source of which is the tissue destroyed by roentgen rays. Githens[13] explained the relatively high globulin content of dogs' blood during starvation and after repeated bleedings by the assumption that since globulin is nearer in composition to the protein of the organs, it enters the blood from such tissues under conditions involving blood globulin depletion. As previously stated, the hemoglobin of these dogs was but little altered during the experiments; hence the increase in serum globulin cannot be attributed to the bleeding. It is, however, generally conceded that tissue

Table IV

Albumin and Globulin of Dog Sera before and after Irradiation

Group	Dog	Weight kilos	Albumin-Globulin Ratio									Remarks
			Pre-treatment				Post-treatment					
			2 wks.	1 wk.	6 hrs.	20 min.	24 hrs.	48 hrs.	1 wk.	4 wks.	6 wks.	
I	1	6	2.31	2.26	2.08	2.14	1.71	2.00	2.12	2.29	2.15	500 r (air value) 600 r surface dose over posterior lower body (160–180 kv., 50 cm. focus skin distance) 0.25 mm. Cu, 1.0 mm. Al.
	2	9	2.29	2.13	1.53	2.40	1.74	2.06	2.23	2.32	2.23	
	3*	11	3.74	3.35	3.02	3.77	3.21	3.07	3.22	3.04	3.20	
II	4	7.2	2.63	2.76	2.27	2.65	2.31	2.61	2.71	2.38	2.77	500 r (air value) over posterior chest.
	5	6.9	1.56	1.67	1.52	1.38	1.28	1.50	1.57	1.47	1.46	
	6*	9.0	3.61	3.60	3.00	2.95	2.91	2.90	2.94	2.82	2.96	
III	A	10.5	2.68	2.46	2.49	1.30	1.73	1.74	2.68	2.64	2.77	500 r (air value) over anterior and posterior lower body.
	B	9.0	2.94	2.82	2.96	2.36	2.21	2.80	2.43	2.64	2.79	
	9*	7.0	2.29	2.15	2.08	2.14	2.22	2.26	2.01	2.13	2.11	

* Untreated control dogs.

destruction accompanies exposure to roentgen rays; therefore such a source of globulin replenishment in the blood is quite conceivable. If this be the case, there is then offered a possible explanation for both the immediate and the delayed increases of serum globulin; the immediate resulting from more massive destruction of tissue as a consequence of the longer exposure, and the delayed appearance of globulin increase being due to less tissue injury and a perhaps somewhat slower rate of tissue disintegration when the animals were subjected to but half the dose. The effect of irradiation on the serum albumin and globulin is apparently less related to the part of the body exposed than to the order of magnitude of the dose.

During the course of these investigations opportunity arose to study the effects of irradiation on dogs suffering from an infection of unknown origin. Two of the dogs in which the infection developed had been under observation for some time, and data had been obtained upon them as normal animals. The dogs appeared to be in good condition at the taking of blood samples one week before the infection was noticed. The first manifestations were marked loss of weight, general weakness, and many pustules diffusely spread over the ventral surface and about the mouth. Blood samples were taken and six hours later the dogs were exposed to radiation, using the double dose as described for the irradiated dogs of Group III. The protocols of these two dogs, 7 and 8, are given in Table V. Constitutional reactions following the treatment were immediately evident. The animals became extremely weak and nauseated. From day to day they became progressively more weakened and greatly emaciated; vomiting continued; diarrhea with bloody stools developed; finally the dogs were completely prostrated and died. The interval between exposure to roentgen rays and death was five days in dog number 8 and ten days in dog number 7. As the other dog manifesting the infection had not been under observation previous to the occur-

TABLE V

THE EFFECT OF IRRADIATION ON CERTAIN SERUM CONSTITUENTS OF DOGS SUFFERING FROM INFECTION.

Dog	Time of Bleeding		*p*H of Serum		Serum CO_2 Combining Power c.c. per cent	Serum Albumin and Globulin			Weight (kilos)	Remarks
	Before Exposure	After Exposure	Elec.	Col.		Alb. per cent	Glob. per cent	Ratio		
7	2 wks.	—	7.36	7.35	60.6	3.47	1.74	2.15	8	500 r (air value) over posterior and anterior lower body.
7	1 wk.	—	7.45	7.43	50.4	3.69	1.65	2.24	—	
7	6 hrs.	—	7.45	7.43	49.0	2.79	1.21	2.30	6	
7	—	20 min.	7.45	7.45	55.7	2.95	1.15	2.56	—	
7	—	24 hrs.	7.37	7.35	50.4	2.95	1.15	2.56	—	
7	—	48 hrs.	7.26	7.28	42.6	3.04	1.13	2.69	5	
7	—	1 wk.	7.33	7.31	51.3	3.54	1.13	3.13	3	Dog died ten days after exposure.
8	2 wks.	—	7.45	7.47	54.1	3.00	1.45	2.07	9.2	500 r (air value) over posterior and anterior lower body.
8	1 wk.	—	7.35	7.36	60.6	3.14	1.22	2.57	—	
8	6 hrs.	—	7.35	7.36	56.6	3.40	1.53	2.22	7.0	
8	—	20 min.	7.35	7.36	60.6	3.43	1.46	2.35	—	
8	—	24 hrs.	7.40	7.38	58.9	1.04	1.00	1.04	—	
8	—	48 hrs.	7.49	7.50	54.1	3.41	1.45	2.35	3.2	Dog died five days after exposure.

rence of the infection, no serum analyses were made. This animal, manifested similar though somewhat less severe symptoms, the vomiting and diarrhea were of short duration and although the dog became very emaciated and weak he began to recover and at the end of one month was apparently well again. The data obtained upon the irradiated dogs do not show such graphic alterations in the serum constituents as might be expected. The *p*H and CO_2 capacity remain well within physiological limits and do not vary markedly from those noted either before the onset of the infection or the treatment. Contrary to expectation, neither the albumin nor the globulin content of the serum seems to have been much affected by the presence of infection, although this infection evidently caused considerable tissue destruction. It has been frequently observed that the most significant variations in serum proteins occur in the course of infection and wasting disease. According to Leendertz,[21] in all wasting diseases accompanied by tissue destruction, the globulin is increased. Berger[2] states that most local and general diseases have been found to influence the protein content to some extent and in various directions. In the opinion of the latter the chief qualitative change is an increase in globulin, as a chemical expression of almost all pathological processes with general manifestations. It is possible that the infection in these two dogs had not progressed sufficiently to have notably altered the proteins of the serum at the six hour pre-treatment period. The animal dying within five days of the treatment exhibited a marked decrease of serum albumin content and also of globulin content twenty-four hours after exposure. At this time the albumin-globulin quotient was appreciably lowered. Otherwise the serum proteins remained within the normal limits although the dog was very sick and died so soon after treatment. The dog which succumbed rather more slowly to the cumulative effects of irradiation and infection manifested no change in either the albumin or globulin of the serum except a slight drop in both, noted at six hours before treatment, which was sustained throughout the forty-eight hour observation. Again at one week after exposure the albumin had risen to the pre-treatment and pre-infection ranges, while the globulin remained low, thus resulting in a higher ratio.

Unfortunately it was not possible to obtain necropsies on these dogs. Although the changes in the blood constituents concerned with this work are not particularly significant, the death of the infected dogs after irradiation contrasted with the recovery of the untreated infected animal, graphically illustrates the breakdown of the already burdened organism when subjected to the additional metabolic stress consequent to roentgen-ray exposure.

SUMMARY

1. Forty-five analyses of the serum of the blood of 9 normal dogs have been made investigating the albumin and the globulin content and the acid-base balance. The serum proteins are found to be within the range established for the serum albumin and globulin of human beings. In these dogs the serum shows a somewhat greater individual variation than is ordinarily encountered in man. The CO_2 capacity of the sera of these dogs lies near the lower limit of the accepted range for human sera.

2. Six normal dogs were subjected to roentgen-ray exposure, 500 r (air value); two of the dogs were irradiated over the posterior chest, two over the posterior lower body, and two over the anterior and posterior lower body. In each group, one untreated dog served as a control.

3. Analyses of the sera of the irradiated dogs demonstrated no appreciable changes of *p*H or of CO_2 combining power of the serum of normal dogs after exposure. Alterations of the serum protein content are noted in the irradiated animals; an immediate decrease of both the serum albumin and the serum globulin is observed in the majority of the dogs after treatment. The globulin returns to the pre-treatment level or

above within twenty-four hours of the exposure; the albumin remains low throughout the forty-eight hour observation. Changes in the serum proteins as a result of roentgen-ray exposure are apparently dependent upon the order of magnitude of the dose rather than upon the part of the body exposed.

4. A study of the effect of irradiation on dogs suffering from a generalized infection is presented. Two infected dogs which were irradiated over the anterior and posterior lower body died a few days after while a similarly infected dog not so treated survived. The blood changes in the treated infected dogs did not differ materially from those of the treated normal dogs.

5. Throughout these studies comparative estimations of the *p*H of dog sera were made by the electrometric and by the colorimetric methods, using the Hastings hydrogen ion colorimeter for the latter. Very close agreement between the two methods was obtained. It is concluded that the colorimetric method as here employed is reliable for studies of the *p*H of dog sera.

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THE *p*H OF HUMAN MIXED SALIVA DURING IRRADIATION FOR INTRAORAL CARCINOMA*

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IN THIS investigation the chemical and physical properties of human mixed saliva in patients with intraoral carcinoma have been studied in the hope of furnishing a more accurate understanding of oral conditions during irradiation. The immediate and late effects of irradiation on mixed saliva have been demonstrated in this way. Also oral sepsis has been shown to play a complicating rôle during the irradiation cycle which is of the utmost importance to the comfort and cure of the patient.

One hundred and ninety cases with intraoral carcinoma were selected. The *p*H of mixed saliva on these cases was determined colorimetrically and the changes in quantity and viscosity were noted. The conditions of the oral mucosa, teeth, gums, and tonsils were observed at the time of each test with special reference to infection and moisture.

The methods for collection of the specimens were similar to those used by Starr,[9,10] Clark,[3] and others. The procedure was briefly as follows: All specimens were taken between 2 and 4P.M. after the patient had rested one hour and a half in a booth by himself, during which period he took nothing by mouth and was advised to breathe through the nose and keep the mouth closed. The collection was made over a period of ten minutes. As the patient bent forward the saliva flowed through a glass tube, one end of which was in his mouth, the other in 2–3 cm. of neutral oil in a test tube. Specimens were not used when excessive blowing was needed to produce the small amount of saliva for the test nor when the patient suffered an abnormal emotional reaction toward the procedure. It is interesting to note here that this simple procedure upset two patients emotionally to such an extent that they were unable to produce a specimen. One of the patients tried three times without result. With a duplicate test in the majority of cases and with the above precautions, we feel sure that the analyses are accurate.

Dr. Helen Woodard performed the analyses and the method used is described by her below.

METHOD FOR DETERMINING *p*H OF SALIVA

The *p*H of the saliva was determined colorimetrically as follows: A series of nineteen buffer standards was set up for the *p*H range 5.0 to 7.6 in test tubes of colorless glass and uniform bore. Sorenson phosphate buffers standardized with the potentiometer were used for the *p*H values 6.6 to 7.6; LaMotte buffer standards were used for the lower range. The indicators were propyl red and bromthymol blue in alcoholic solution. These were brought to *p*H 5.6 and 6.6 respectively before being used. The color standards containing bromthymol blue were found to keep almost unchanged for two weeks; those containing propyl red faded rapidly and were made up fresh every week.

All specimens of saliva were collected and kept in test tubes under layers of neutral white paraffin oil about 4 mm. thick. As many samples of saliva contained only 1 or 2 c.c., no attempt was made to centrifuge out the mucus. Two or three tenths of a cubic centimeter of the mixed specimen was removed with a pipette and added to 2 c.c. of distilled water of *p*H 6.6. Sufficient indicator was then added from a dropping bottle to give the same depth of color as that of the standards. The color of the unknown was then compared with that of the standard against a white background. All determinations were done in duplicate and

* From the Head and Neck Department of the Memorial Hospital, New York City.

usually checked within 0.1 *p*H. There was no evidence that the mucus contained in the specimen differed in reaction from the saliva itself.

All the determinations were made at room temperature, which ranged from 20° to 30°C. Most of the determinations were made within an hour of the time the specimen was obtained. When it was necessary to keep specimens longer than this, they were kept in the ice box. It was found that the average change in the *p*H readings of 9 specimens kept at room temperature for five hours was −0.05 *p*H; the average change in 5 specimens kept for eighteen hours at 4°C. was −0.06 *p*H. The largest change observed was 0.3 *p*H after five hours at room temperature. Hence it was felt that keeping the specimens for one hour at room temperature or over night in the ice box did not materially decrease the reliability of the determinations.

TABLE I

			Number	*p*H	Number	*p*H
Controls—Individuals without carcinoma					8	6.7 ± 0.1
Patients with Intraoral carcinoma	Without ulceration	Without pyorrhea	12	6.7 ± 0.1	47	6.6 ± 0.2
		With pyorrhea	35	6.5 ± 0.2		
	With ulceration				36	6.0 ± 0.2

THE SALIVA *p*H ASSOCIATED WITH NON-ULCERATED INTRAORAL CARCINOMA AS OPPOSED TO ULCERATED LESIONS

In controls from apparently normal individuals eight analyses gave an average *p*H of 6.7 ± 0.1, as shown in Table I. This compares with Starr,[10] Barlow,[1] and others.

Patients were classified into two main groups: those with, and those without ulcerations on the mucosa of the oral cavity. Patients with non-ulcerating intraoral lesions had an average *p*H of 6.7 ± 0.1. Therefore, an abnormal saliva *p*H (acid reaction) cannot be considered an etiological factor for intraoral carcinoma as the saliva *p*H of normal individuals coincides closely with that of patients with non-ulcerating carcinomas.

The group with ulceration included a wide range of patients with various sized lesions. This group had an average *p*H of 6.0 ± 0.2 or a more acid saliva.

Pyorrhea, which is nothing less than a superficial ulceration, cannot be considered separately here because it is always present with an ulcerating lesion. In the group without ulceration, however, pyorrhea is associated with a saliva slightly more acid (*p*H 6.5 ± 0.2) than in the same group without pyorrhea (*p*H 6.7 ± 0.1) as shown in Table I. This difference is not marked in all cases but the averages are suggestive of the association of infection with a more acid saliva.

All ulcerated lesions were found to have some degree of slough on the surface. This suggests that the constituents of slough are the primary factors in altering the *p*H of mixed saliva in patients having ulcerated intraoral carcinoma.

THE ACTIVE FACTORS IN RAISING THE ACIDITY OF SALIVA IN THE PRESENCE OF ULCERATION

The mouth and hypopharynx are regularly the habitat for numerous bacteria and yeasts. Sloughing epithelium, deep devitalized tissues, ulcerated areas, decayed teeth, pyorrhea, and food particles, furnish abundant nutrition and lodgment. In addition, catarrhal inflammation which is rarely

absent in the normal adult mouth and invariably present with intraoral neoplasms, particularly favors bacterial growth upon the membranes and reduces the resistance in underlying tissues. Although no culture study was made on the bacteria and yeasts here it seems logical to assume that those commonly found in the mouth by Castellani,[2] Hiss and Zinsser[5] and others, would be present in abundance in such a favorable environment. The acid-forming bacteria and yeasts mentioned in the above references seem to us to be the activating factors for lowering the *p*H of saliva. This is substantiated by the follow-up observation that the *p*H is shown to rise to the normal average in the ulcerated mouth after slough and infection were cleared up.

Table II
Individual *p*H Irradiation Cycles

	Before Irradiation		During the Acute Irradiation Reaction		Two months after Irradiation	
	*p*H	Viscosity	*p*H	Viscosity	*p*H	Viscosity
1. H.A.	5.9	++	6.5	++++	5.7	++++
2. S.B.	6.3	+	6.9	++	6.4	+++
3. S.L.B.	6.3	+	6.8	++	5.4	+++
4. J.C.	6.9	++	7.5	+	6.9	++
5. P.D.	6.5	++	6.6	+	6.5	++
6. M.F.	6.3	++++	6.8	++++	6.1	++++
7. J.G.	—		6.6	++	6.2	+++
8. H.J.	5.8	++++	6.1	+++	5.7	++++
9. J.M.	5.4	++	5.9	+++	5.6	++++
10. J.H.M.	6.3	++	6.5	+++	5.9	++++
11. N.P.	—		6.3	+	5.3	+++
12. C.S.	—		6.1	++++	5.7	++++
13. G.S.	6.0	++++	6.4	+++	5.8	++++
Averages	6.1		6.5		6.0	

The *p*H Cycle of Saliva During Irradiation

Routine saliva examinations reveal additional information regarding the salivary changes during irradiation. Saliva specimens were taken first before any treatment, then during the acute reaction, and, finally, two months after treatment by interstitial irradiation. As shown in Table II a sufficient number of cases was followed to demonstrate that combined external and interstitial irradiation alters the *p*H, the viscosity and quantity of saliva. As shown by the averages, the *p*H curve, if it may be so designated, starts with the individual low (*p*H 6.1), rising during the acute reaction (*p*H 6.5) and returning approximately to the initial value during the post-irradiation period (*p*H 6.0). During the acute phase of the radium reaction, the saliva increases in amount and it becomes less viscous. The temporary increase in *p*H (less acid reaction) with the increase in quantity of saliva may be due to the fact that the stimulated salivary glands secrete more and that the saliva does not remain the normal length of time in the mouth during the acute phase of treatment to become saturated with CO_2 at the CO_2 tension of expired air. Such relatively unsaturated saliva because of its low CO_2 content, would have a higher *p*H than normal saliva.

As shown above, the *p*H of the post-irradiation specimen taken two months after active treatment returns to an abnormally low *p*H which is lower than the pre-irradiation reaction. A further demonstration of this point is shown in a group of 30 cases from our series of cancer of the

tongue, cheek and floor of the mouth. All patients received both external and interstitial irradiation. Specimens were analyzed in the two months' post-irradiation period and were found to have an average *p*H of 6.1 ±0.3 with a viscosity of 3 plus or 4 plus in all cases. This abnormally acid *p*H compares with the post-irradiation *p*H as shown in Table II. This viscid, acid saliva is very slow to disappear and we find in many instances that it is a permanent impairment.

When external irradiation is given alone, on the other hand, the saliva becomes more acid (lower *p*H) and decreases in amount. It becomes a viscid mucus without the period of excessive salivation resulting from the combined treatment. The only influencing factor appears to be the direct irradiation effect on the salivary glands which is temporary swelling followed by fibrosis. This glandular system is particularly susceptible because of its close proximity to the skin and secondly because of the wide skin portals customarily used for irradiation of the neck. The duration of the altered salivation is dependent directly upon the extent of external irradiation, and treatment by this means may be guided advantageously at times by the condition in the oral cavity.

Interstitial irradiation alone temporarily increases the quantity and *p*H of saliva and diminishes the viscosity. Salivary changes from this type of treatment are due to the local inflammatory reaction in the mucosa, analogous to a burn. It is readily understandable that interstitial irradiation would not in most cases appreciably affect the salivary glands themselves because of their wide distribution and distance from the area treated.

EFFECT ON *p*H BY THE REMOVAL OF ONE OR MORE GLANDS OF THE SALIVARY SYSTEM

The effect of the removal of one or both submaxillary salivary glands on the properties of the mixed saliva has never been studied. Complete unilateral neck dissections, including the submaxillary salivary gland, were done on a large number of patients in this series. Specimens were taken before and after operations but since all the patients received preoperative external irradiation the results to date are not conclusive. A diminution in the amount of saliva was observed and an acid saliva *p*H was found. However, a sufficient number of cases have not been followed to determine whether the abnormal acid saliva was due to the removal of one submaxillary gland or to the roentgen treatment. In a similar manner, the parotid and sublingual glands may be considered. As the data increase, we hope to throw some light on this subject.

CONCLUSIONS

1. Oral infection is associated with an abnormally acid mixed saliva.
   (*a*) Normal individuals have an average saliva *p*H of 6.7 ±0.1.
   (*b*) Patients with intraoral cancer accompanied by ulceration and slough have a more acid *p*H (6.0 ±0.2) than patients without ulceration (6.6 ±0.2).
   (*c*) Patients with a normal oral mucosa with pyorrhea have a more acid *p*H (6.5 ±0.2) than those without pyorrhea (6.7 ±0.1).
2. An abnormally acid saliva is not an etiological factor in intraoral carcinoma.
3. Slough is the active factor in lowering the *p*H (acidifying the saliva) because of its property as habitat for acid-forming bacteria and yeasts.
4. The saliva *p*H for the individual patient taken during the three phases of irradiation forms a curve, starting with an abnormally acid saliva (*p*H 6.1), rising during the acute reaction (*p*H 6.5) and returning approximately to the pre-irradiation value during the post-irradiation period (*p*H 6.0). This may be called the optimum *p*H cycle for saliva during irradiation for intraoral carcinoma.

The author wishes to acknowledge his indebtedness to Dr. Douglas Quick for many helpful suggestions and for the use of patients in his department. He wishes to express his thanks to Dr. Helen Woodard for her cooperation in performing the chemical analyses.

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THE EFFECT OF RADIATION ON THE ACIDITY OF BLOOD

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NEW YORK CITY

THE gastrointestinal disturbance which occasionally follows roentgen treatment has made the problem of the physiological changes associated with irradiation one of peculiar interest to clinicians and research workers. Practically every known blood and urine constituent has been estimated before and after irradiation, in the hope of finding the cause of "radiation sickness," but while some workers report positive results in one direction, in nearly every case others report results in the opposite direction, so that in spite of an enormous bibliography on the subject there are almost no clear cut and uncontradicted results.

Attempts to substantiate the theory that radiation induces cell catabolism have resulted in a number of papers dealing with the concentration in blood and urine of such end products as uric acid, urea, and amino acids. Behrens[1] and Wichels and Behrens[21] claim a change in the albumin /globulin ratio in blood following irradiation, while Loeper and Tonnet[13] find an increase in the concentration of globulin and amino acids. Hirsch and Petersen[9] in a paper which contains an excellent bibliography of the subject, present results to show that there is no consistent change in non-protein nitrogen, uric acid, urea or creatinine, following the irradiation of human subjects, while Doub, Bolliger and Hartman,[6] working with human beings and also with dogs, find a definite increase in uric acid in blood, and a drop in non-protein nitrogen and amino acids.

In the matter of blood sugar there is a similar lack of agreement, Loeper and Tonnet finding an increase, Tsukamoto[19] working with rabbits, getting no change except when the liver is irradiated, Hirsch and Petersen claiming no consistent change in human subjects, while Strauss and Rother[18] get a drop followed by a compensatory increase.

Blood cholesterol changes have been extensively studied, with equally confusing results. Mattick and Buchwald[14] claim that there is a drop in the cholesterol content of blood, followed by a sustained rise; Burgheim and his coworkers[3,4,12] find that roentgen rays cause a rise in blood cholesterol if the patient has carcinoma or sarcoma, while Hubert,[10] on the other hand, gets a fall in cholesterol if the patient has an inoperable carcinoma, but a rise if the patient has been operated on and is free from metastases. Brunton[2] in 25 cases of malignancy found no constant change in blood cholesterol.

Turning to the question of the acidity of the blood, Hussey[11] working with rabbits and low voltage roentgen rays, found an uncompensated alkali excess three to five hours after irradiation, while Reding and Slosse[16] find that the alkalosis which they note to be characteristic of cancer patients is decreased in those cases in which irradiation proves to be of benefit to the patients. If the patient does not respond beneficially to the treatment his alkalosis is increased by the irradiation. Hirsch and Petersen report an increased hydrogen ion concentration immediately after irradiation, followed by a decrease.

In view of the complete lack of uniformity in the results available in the literature, it seemed of interest to follow some of these blood changes in patients irradiated at this hospital. The present paper presents the results obtained in a study of the *p*H, CO_2 combining power and lactic acid concentration in the blood of patients before and

after therapeutic irradiation. For comparison, the p_H of rabbit blood was studied before and after very heavy irradiation of the animals.

METHOD

The *p*H determinations were made by the method of Myers[15] and Cullen.[5] A Myers bicolorimeter was used. Details of the method are given in a previous paper.[22] The same method was used for the animal work, except that hundredth normal acid and alkali were used in the colorimeter wedges, instead of phosphate buffers. Both methods gave a precision of ±0.01 *p*H in favorable cases, with a maximum deviation of ±0.02 *p*H.

The carbon dioxide combining power of blood plasma was determined with a micro van Slyke apparatus, the precision being ±1 volume per cent.

The lactic acid determinations were made according to the Friedemann, Cotonio and Shaffer method[8] as modified by Ronzoni and Wallen-Lawrence[17] for blood, as described in a previous paper.[7] The proteins were precipitated by adding one volume of mercuric nitrate to blood previously laked in 5–6 volumes of water, and the reaction adjusted accurately to *p*H 7.0–7.5 before making up to volume and filtering. The filtrate was cleared of excess mercury with hydrogen sulfide, and this filtrate freed of H_2S by aeration, and of carbohydrates according to the van Slyke procedure[20] using copper sulfate and calcium hydrate. Lactic acid was estimated in this final filtrate by oxidation with potassium permanganate, the resulting acetaldehyde being caught in bisulfite. The results are expressed in milligrams of lactic acid per 100 c.c. blood. A variation of ±5 per cent is inherent in the method, and probably no change of less than 10 per cent in the concentration of blood lactic acid could be considered significant. That is, a change of 3 mg. per cent or less is within the experimental error of the method.

Human blood was drawn from an arm vein with brief stasis. Rabbit blood was drawn from an ear vein, dry heat being employed to produce venous engorgement. Occasionally a light painting of xylol was also used. All blood samples were taken in oiled Luer syringes. Oxalate was used as an anticoagulant. Blood was preserved in the ice box in all cases where the chemical examination could not be made within an hour after it was drawn. Experiment showed that the factors we were measuring are not changed in twenty-four hours at ice box temperature.

MATERIAL

The human cases were patients attending the roentgen department of this hospital. No patients were examined who were acutely ill prior to irradiation, who had impaired kidney function, lesions of the stomach, or any other condition likely to cause grave impairment of the general metabolism. The distribution of tumors from which these patients were suffering is shown in Table 1. Since patients receiving radiation on the neck or extremities seldom suffer from radiation sickness, only four such cases were studied. The cases with tumors of the uterus, ovary, rectum, and one case of melanoma of the foot were irradiated over the pelvic region. Cases of benign or malignant disease of the breast, chest, and clavicle were irradiated over various portions of the thorax.

In all cases but two the radiation received by the patient consisted of one skin erythema dose of high voltage roentgen rays. The remaining two received a skin erythema dose of low voltage roentgen rays over an ulcerated lesion of the breast. These two patients were not nauseated after treatment.

Specimens of blood were drawn from each patient before treatment. Whenever possible two samples were taken after treatment, one one-fourth to three hours after the completion of irradiation, and another eighteen to twenty-four hours after irradiation. In some cases only one post-irradiation sample could be obtained.

The patients differed greatly in their constitutional reaction to treatment. In

TABLE I

BLOOD CHANGES FOLLOWING IRRADIATION

Case	Sex	Diagnosis	*p*H Change 0–3 hrs.	*p*H Change 18–24 hrs.	†CO_2 Change 0–3 hrs.	†CO_2 Change 18–24 hrs.	‡Lactic Change 0–3 hrs.	‡Lactic Change 18–24 hrs.
1	F	Ca uterus					−1	−8
2	F	Ca cervix	+0.01		−2		−6	
3	F	Ca cervix			+1	−2	−6	−3
4	F	Ca cervix	+0.12		−6			
8	F	Ca cervix	0.00		−2		−1	
13	M	Hypernephroma	+0.04	+0.10	−3		+5	+5
18	F	Ca breast	−0.02	−0.07	+8	+9		
19	F	Ca cervix	−0.03	−0.03	+2	+4	Av. = −2	
22	F	Ca cervix	−0.03	+0.04	+1			
23	F	Ca cervix		0.00		−1		
29	F	Ca cervix	+0.01		Av. = −0.1			
				Av. = +0.01				
			Av. = +0.01					
		CASES NOT NAUSEATED AFTER TREATMENT						
5	F	Ca uterus	+0.01	+0.02	0		+5	+3
6	F	Ca cervix	−0.03	0.00	+5	0	−12	−11
7	F	Ca ovary			−2	−6	0	−6
9	M	Ca tongue	+0.02				−5	+2
10	M	Ca larynx			+4	+2	−7	0
11	M	Ca rectum					−4	+1
12	M	Ep lip		−0.04		0		−6
14	M	Sa thigh	−0.04	−0.08	+3	+1	−7	+16
15	F	Ca cervix		+0.01		−2		−14
16	M	Mel. foot	0.00	0.00			Av. = −4	
17	F	Ca breast	−0.04	−0.07	−2	+4		Av. = −2
20	F	Ca breast	0.00		−1			
21	F	Ca cervix	0.00	Av. = −0.02	−1	Av. = +0.5		
*24	F	Ca breast	+0.03		0			
25	F	Fibromyoma uterus	+0.03					
26	F	Endocervicitis	−0.01		−2			
27	M	Sa clavicle	+0.03					
28	F	Ca uterus	−0.02		Av. = +0.4			
30	M	Ca lung	−0.01					
31	M	Benign chest	+0.01					
32	F	Ca rectum	+0.02					
33	M	Ca rectum	+0.03					
34	F	Mastitis	0.00					
*35	M	Ca breast	−0.01					
36	F	Ca cervix	0.00					
37	F	Endocervicitis	0.00					
			Av. = 0.00					

* Received one erythema dose low voltage roentgen rays. All others received one erythema dose high voltage roentgen rays.

† Carbon dioxide combining power of blood is given in volume per cent.

‡ Lactic acid content of blood is given in mg. per 100 c.c.

over two-thirds of the cases no effect was observed beyond occasional slight vertigo. In the remainder of the cases there were various degrees of gastrointestinal upset ranging from transient nausea and anorexia to attacks of vomiting and diarrhea lasting twelve to forty-eight hours. All cases showing evidence of digestive disturbance immediately after irradiation are reported as positive for radiation sickness.

The rabbits used were healthy young adult animals of both sexes. They each received one dose of high voltage roentgen rays over the clipped anterior surface of the body. The setting was, 200 kv., 30 ma., 45 cm. target-skin distance, 0.5 mm. copper filter. Two animals were irradiated for forty minutes, 2 for twenty minutes, and 6 for thirty minutes. All these doses were sufficient to cause the death of the animal in three to seven days, there being no direct relationship between time of irradiation and period of survival. All the animals showed tremor, incoordination, diarrhea, and fall in blood pressure immediately after irradiation. The fall in blood pressure was so pronounced that it was impossible to obtain satisfactory blood specimens during the first three hours after treatment. These symptoms disappeared in eight to twenty-four hours, and the animals remained well until one or two days before death.

Blood specimens were taken from each animal before irradiation, and again three to six hours and eighteen to twenty-four hours after irradiation. The *p*H of successive specimens was compared.

RESULTS

The results for human cases are given in Table 1. The changes tabulated are seen to vary within fairly wide limits in both directions, and to bear no direct relation to the presence or absence of radiation sickness. One case, for instance, shows a change of +0.12 *p*H, while another shows a change in the same time interval of −0.04 *p*H. Many of the lactic acid changes are within the limits of experimental error, and of those which are significant, one case shows a drop of 11 mg. per 100 c.c. after eighteen to twenty-four hours, while in another there is an increase of 16 mg. per 100 c.c. Among the cases which showed radiation sickness the significant changes in the first three hours run from −6 to +5 mg. per 100 c.c.

Twenty-three of the patients were irradiated over the pelvis, 9 over the thorax, 4 over the neck or extremities, and one over the lumbar region. Of the patients who were nauseated after treatment, 9 were irradiated over the pelvis, and one each over the thorax and lumbar region. It is thus seen that patients irradiated over the pelvis were more subject to radiation sickness than the others.

No significant change was observed in the plasma *p*H of rabbits within three days after the animals had received a lethal dose of high voltage roentgen rays. The average changes observed were:

−0.01 *p*H for 9 animals observed 3–6 hours after irradiation
−0.01 *p*H for 9 animals observed 18–30 hours after irradiation
−0.01 *p*H for 7 animals observed 48–72 hours after irradiation

These animals refused food after irradiation, but in only one animal did the period of anorexia exceed twenty-four hours. The possibility of the development of a starvation acidosis which might be confused with the effect of roentgen rays was investigated by confining healthy animals with access to water but not to food for different periods. The average change in plasma *p*H observed after twenty-four hours' starvation was only −0.01 *p*H. Three animals which were starved forty-eight to seventy-two hours showed an average change of −0.06 *p*H. As the period of anorexia following irradiation usually did not exceed twenty-four hours, starvation cannot be considered to be a factor in the reaction of the blood of the rabbit following irradiation.

At autopsy 6 rabbits which had died or were killed when moribund showed spasm of the pylorus which had apparently persisted for several days. Three others which had received subcutaneous injections of

atropin consisting of 1/150 to 1/50 gr. daily for three days before death also showed pyloric spasm.

SUMMARY

No consistent change was observed in the *p*H, CO_2 combining power, or lactic acid content of the blood of patients after they had received one skin erythema dose of high voltage roentgen rays.

No significant difference was observed in the blood picture between patients suffering from radiation sickness and those in whom irradiation produced no constitutional effects.

No significant change was observed in the blood *p*H of rabbits after the administration of lethal doses of high voltage roentgen rays.

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SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. John T. Murphy, 421 Michigan St., Toledo, Ohio.
Thirty-second annual meeting: Atlantic City, N. J., 1931.

American College of Radiology
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual Meeting: Philadelphia, 1931.

Section on Radiology, American Medical Association
Secretary, Dr. G. W. Grier, Jenkins Arcade, Pittsburgh, Pa.
Annual meeting: Philadelphia, June 8–12, 1931.

Radiological Society of North America
Secretary, Dr. I. S. Trostler, 812 Marshall Field Annex, Chicago, Ill.
Seventeenth annual session: to be announced.

Radiological Section, Los Angeles County Medical Society
Secretary, Dr. John F. Chapman, 209 Professional Bldg., Pasadena, Calif.
Meets on the third Wednesday of each month at the California Hospital.

Radiological Section, Southern Medical Association
Secretary, Dr. W. S. Lawrence, Medical Arts Bldg., Memphis, Tenn.

Brooklyn Roentgen Ray Society
Secretary, Dr. J. J. Masterson, 401-76th St., Brooklyn, N.Y.
Meets monthly on the first Tuesday from October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

Chicago Roentgen Society
Secretary, Dr. George M. Landau, 660 Groveland Park.
Meeting second Thursday of each month October to May inclusive at Virginia Hotel.

Cleveland Radiological Society
Secretary, Dr. A. Srauss, 518 Medical Arts Bldg.
Meetings are held at 6:15 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital.
Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Central Illinois Radiological Society
Secretary, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

Indiana Roentgen Society
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

Milwaukee Roentgen Ray Society
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee.
Meets first Friday in October, December, February and April.
Place of meeting designated by the president.

Minnesota Radiological Society
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.
Next meeting, to be announced.

New England Roentgen Ray Society
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

New York Roentgen Society
Secretary, Dr. J. Bennett Edwards, Englewood Hospital, Englewood, N. J.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

Central New York Roentgen Ray Society
Secretary, Dr. Robert C. Hall 258 Genesee St., Utica, N. Y.
Three meetings a year—January, May and November.

Pennsylvania Radiological Society
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Next meeting, Penn. McKee Hotel, McKeesport, Pa., May 13–14, 1931.

Philadelphia Roentgen Ray Society
Secretary, Dr. Karl Kornblum, 3400 Spruce St.
Meeting first Thursday of each month from October to May inclusive, at 8:15 p.m., in Thomson Hall, College of Physicians, 19 S. 22d St.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. Camp C. Thomas, 476 Lake Ave.
Meets monthly on the first Friday evening at 7:45 at the Rochester Medical Association Building.

St. Louis Roentgen Club
Secretary-Treasurer, Dr. L. R. Sante, Missouri Building.
Meets first week of each month. Time and place of meetings designated by president.

Texas Radiological Society
Secretary-Treasurer, Dr. C. F Harris, Houston, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

University of Michigan Roentgen Ray Society
Secretary, Dr. D. M. Clark, University Hospital, Ann Arbor, Mich.
Meets every Wednesday evening from September to July, at 7:30 o'clock in the amphitheatre of the University Hospital.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

VIRGINIA ROENTGEN RAY CLUB
Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.
Next meeting, to be announced.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA
Secretary, Dr. Francisco Padron, Enrique Villuendas 64, Havana, Cuba. Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch.
Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

SOCIETE DE RADIOLOGIE MÉDICALE DE FRANCE
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE.
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

SÜD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE ROENTGENGESELLSCHAFT
Meets annualy in different cities.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Nicolae Busila, 44 Elizabeta Blvd., Bucarest.
Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly on the first Monday at 8 o'clock in the State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw.
Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. O. Wissing, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets on the first Tuesday of each month from October to July.

THIRD INTERNATIONAL CONGRESS OF RADIOLOGY

The following subjects will be discussed at the Third International Congress of Radiology:

(*a*) Roentgenologic examination of the mucosa of the gastrointestinal tract.

(*b*) Roentgenologic examination of the urinary apparatus by excretion of opaque substances.

(*c*) Pre- and postoperative treatment of cancer of the breast by radiation (recurrence and metastases excepted).

(*d*) Radiotherapy of inflammatory diseases.

(*e*) Diathermic electrotherapy of inflammatory diseases.

At a General Meeting, at which all sections will be present, a thirty minute lecture will be given on each of these subjects. All members of the Congress are invited to give the results of their experience in these fields both by special communications and during the general discussion.

Travels in France. Members of the Congress will benefit by a reduction of 50 per cent on the fare to and from the Congress, on the French railways.

After the Congress several tours at reduced prices will be organized to different parts of France, including visits to various thermal and mineral watering places.

The particulars on the above reduced rates on railway fares and on the tours after the Congress will be forwarded from the offices of the Congress to all members having paid their subscriptions. All information concerning hotel rates in Paris will also be forwarded. Rooms for members of the Congress can be secured if desired through the offices of the Congress.

The Congress is to be held in Paris from the 26th to the 31st of July, 1931. The subscription is 300 French francs for active members and 50 French francs for associate members (persons belonging to the member's family). The abstracts of the papers to be given—400 words maximum, in English, French or German—must be sent in by *April 1, 1931.*

The chairman of the American Delegates Committee to the International Congress of Radiology, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif., will be pleased to give any information concerning U. S. participation in the Congress. If you plan to attend it is advisable to notify the Secretary-General at your earliest convenience.

All correspondence should be addressed to the offices of the Third International Congress of Radiology, 122 Rue La Roetie, Paris 8eme.

MEETING OF AMERICAN RADIUM SOCIETY

The Sixteenth Annual Meeting of the American Radium Society will be held in Philadelphia, Pennsylvania, on June 8 and 9, 1931. The following are the suggestions for the program:

Morning Session: First Day
General papers on radiation dosage including further studies by Failla, Martin and Quimby, etc.
Afternoon Session: First Day
Symposium on malignancies above the clavicle, headed by Dr. Douglas Quick, New York.
Annual Banquet. Presentation of Honorary Members to the Society and remarks by those chosen for Honorary Membership.
Morning Session: Second Day
Symposium on carcinoma of the breast, headed by Dr. Burton J. Lee, New York.
Afternoon Session: Second Day
Symposium on malignancies of the female genital tract, headed by Dr. Henry Schmitz, Chicago.

The Chairman of the Program Committee is Dr. Sanford Withers, 304 Republic Building, Denver, Colorado.

AMERICAN COLLEGE OF PHYSICIANS

The Fifteenth Annual Clinical Session of the American College of Physicians will convene in Baltimore, Maryland, March 23–27, and in Washington, D. C., March 28, 1931. Held in important medical centers, these clinical sessions constitute, per-

haps, the most important postgraduate week in internal medicine. Those who attend the meeting will find ample in the way of clinical, laboratory, research and historical interest, to repay them. As an added feature of the Clinical Session this year, an additional day, March 28, will be spent in Washington, D. C., where a special program of clinics and inspection tours has been arranged under the auspices of the medical departments of the U. S. Army, U. S. Navy, U. S. Public Health Service and Georgetown University.

The entire program of the Clinical Session is characterized by new subjects, new authors and wide geographic representation and the committees have attempted to avoid repetition of subjects and authors. On the General Scientific Programs there will be forty-five or fifty selected formal papers. Symposia on blood diseases, oxygen therapy, diseases of the liver, recent advances in endocrinology with particular reference to the newer work on suprarenal extracts, myocarditis, and several other subjects have been arranged. At Baltimore's many modern and excellently operated hospitals, clinics, ward-walks and laboratory demonstrations will be held. Johns Hopkins Hospital and Medical School, under Dr. Alan M. Chesney, Dean, and a specially appointed committee, will place at the disposal of the College all facilities and offer a program of great interest.

Hotel headquarters will be at the Lord Baltimore Hotel, while general headquarters, at which the registration of members, commercial exhibits and all general sessions will be held, will be The Alcazar, Cathedral and Madison Streets. Transportation on the certificate plan of reduced fares will be available to all physicians and members of their families from all parts of the United States and Canada. A special program of entertainment has been arranged for visiting ladies. The Convocation for the induction of new members, as Masters or Fellows, will be held on Wednesday evening, March 25, and the Annual Banquet will be held on Thursday evening, March 25. The business meeting will be held during the forenoon of Thursday, March 26.

Requests for further information or for programs should be addressed to the Executive Secretary, Mr. E. R. Loveland, 133–135 South 36th St., Philadelphia.

RECENT MEETINGS

At the December meeting of the Radiolocigal Section of the Los Angeles County Medical Association Dr. Lowell S. Goin of Los Angeles was elected President and Dr. John F. Chapman, of Pasadena, Secretary. The meetings are held on the third Wednesday of each month at the California Hospital.

A meeting of the Chicago Roentgen Society was held at the Medical and Dental Arts Building on Wednesday, January 14, 1931. A dinner preceded the scientific program. The following papers were given: "Ventriculography" by Dr. Max Peet, University of Michigan; "Encephalography, Its Indications and Contraindications" by Dr. E. P. Pendergrass, University of Pennsylvania, and "The Use of Air Injections in Nervous Diseases" by Dr. Percival Bailey, University of Chicago. The papers were discussed by Dr. Loyal Davis, Dr. George Hall and Dr. George Davenport.

A combined meeting of the Trudeau Society and the New England Roentgen Ray Society was held at the Boston Medical Library on January 16, 1931. Dinner was served at the Harvard Club. The paper of the evening was given by Dr. Henry D. Chadwick of Detroit, on "The Evolution of Pulmonary Tuberculosis in Children as Revealed in the Roentgenogram."

A meeting of the Central New York Roentgen Ray Society was held on January 24, in Syracuse. Dr. Ulysses S. Kann of Binghamton, New York, was elected President; Dr. Lucas S. Henry, Syracuse, Vice-President, and Dr. Robert C. Hall, Utica, Secretary-Treasurer. It was decided to hold three meetings a year, in January, May and November.

Vol. XXV, No. 2

DEPARTMENT OF TECHNIQUE

Department Editor: David R. Bowen, M.D., Pennsylvania Hospital, Philadelphia, Pa.

TRI-VISION, MULTIPLE, REVOLVING STEREOSCOPE

By HOMER L. SAMPSON
TRUDEAU, NEW YORK

PROBABLY nowhere in the study of films is the use of a stereoscope more valuable than in the interpretation of the evolution of pulmonary shadows. At present the pulmonary field presents a more varied combination of densities than is met with in probably any branch of roentgenology. The many diseases that the lung may be heir to, the almost constantly evolving shadows (one might say daily changes) call for the most satisfactory method of visualizing these progressive or retrogressive evolutions.

It is a reasonable view-point, that as a pathological process evolves, physical changes in the tissues take place. These physical variations are intimately associated with differences in tissue density, which in turn make possible the use of roentgen rays in the detection of disease. Having constantly in mind the fundamentals underlying a given pathological process, it becomes obvious that an attempt should be made to correlate "roentgen shadows" with pathological changes in accordance with pathology as it is now accepted.

We know that as a tree begins to leaf, each leaf is capable of casting a shadow on the ground, but owing to the interposition of other leaves and branches, many fail to register their "shadow pattern," and in consequence one sees the common silhouette familiar to all. As the growth of the tree proceeds, the shading or shadow (as a whole) becomes more uniform, until a point may be reached where the individual shadows have merged with one another to form a reasonably homogeneous entity. Only the more peripheral leaves register their true outline. To look at the tree itself, one is not impressed with this homogeneity. We might compare the shadow on the ground to a single (flat) roentgenogram with all the shadows of the leaves and branches registering in one plane; and the other, to a stereoscopic view of the tree itself.

Virtually the same situation exists in roentgenograms, particularly of the chest. The single flat film reveals all the shadows in one plane, whereas stereoscopic films, properly taken and properly viewed, present shadows in their truer values. Certain fundamentals must be incorporated in a stereoscope to facilitate accurate interpretation. Among them is a central source of light with a uniform distribution, with possibly a rheostat to change the intensity of the light. If the technique of taking the films has been correct, very little adjusting mechanism to control the prisms is necessary. A simple sliding arrangement is adequate.

This brings us to a most important part of the stereoscope; the ocular prisms or mirrors. While a bit expensive, triangular prisms are ideal, although a perfect surface reflector of some other sort might readily suffice. That prisms or surface reflectors have an advantage over thick mirrors can readily be demonstrated. The latter may reflect double images, thereby interfering materially with correct interpretation.

The revolving feature of a stereoscope is readily apparent after a few trials. By this arrangement one can retain "in the eye" the shadows of one set of films, to superimpose them on the next set when turned into view. Under such conditions it is not necessary to carry the impression any great length of time, which is not possible in the non-revolving type of stereoscope. Again, if the technique of making the films of a

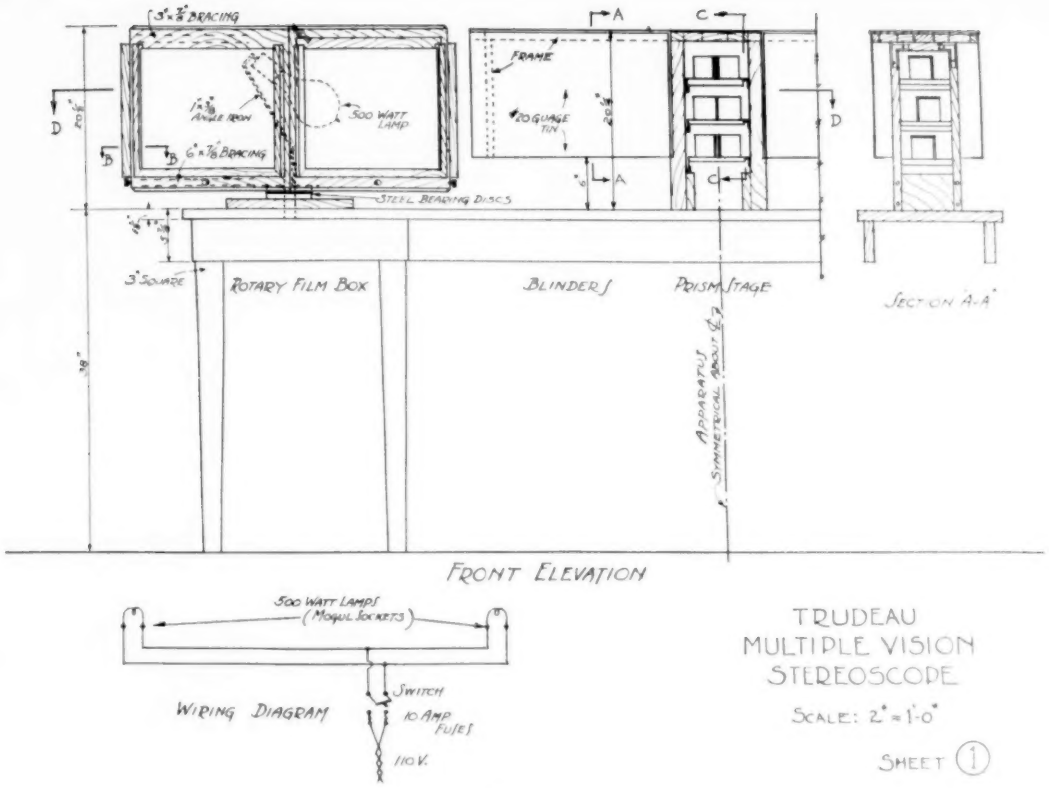
3"x 7/8" BRACING
1"x 3/8" ANGLE IRON
500 WATT LAMP
6"x 7/8" BRACING
FRAME
20 GUAGE TIN
STEEL BEARING DISCS
3" SQUARE
ROTARY FILM BOX
BLINDERS
PRISM STAGE
APPARATUS SYMMETRICAL ABOUT ℄
SECTION A-A
FRONT ELEVATION
500 WATT LAMPS (MOGUL SOCKETS)
SWITCH
10 AMP FUSES
110 V.
WIRING DIAGRAM
TRUDEAU
MULTIPLE VISION
STEREOSCOPE
SCALE: 2"=1'-0"
SHEET (1)

FIG. 1

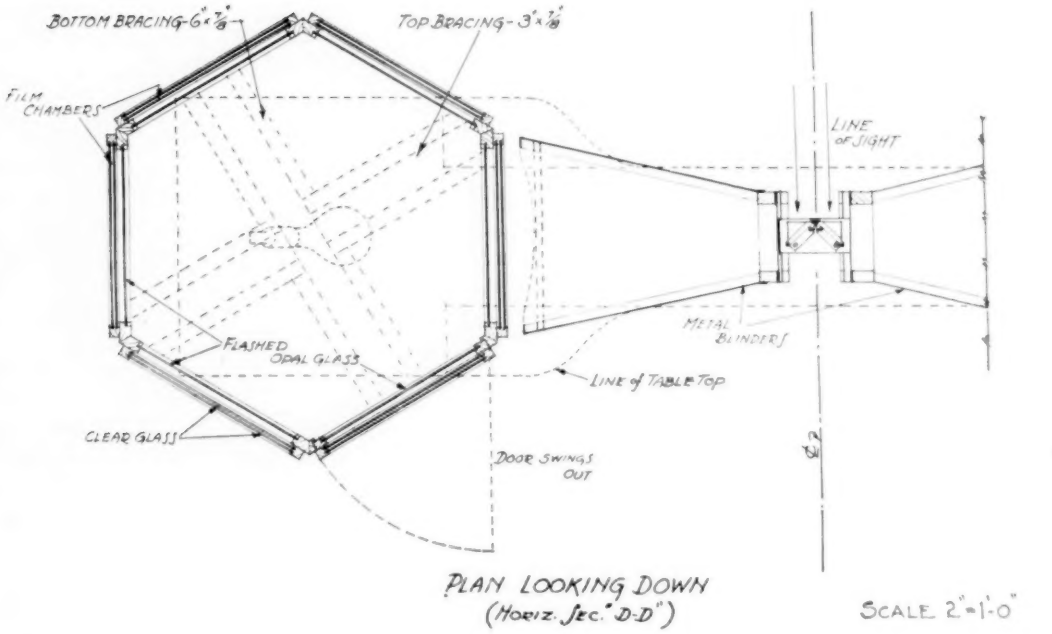
BOTTOM BRACING-6"x 7/8"
TOP BRACING-3"x 7/8"
FILM CHAMBERS
LINE OF SIGHT
METAL BLINDERS
FLASHED OPAL GLASS
LINE of TABLE TOP
CLEAR GLASS
DOOR SWINGS OUT
℄
PLAN LOOKING DOWN
(HORIZ. SEC. "D-D")
SCALE 2"=1'-0"
SHEET (2)

FIG. 2

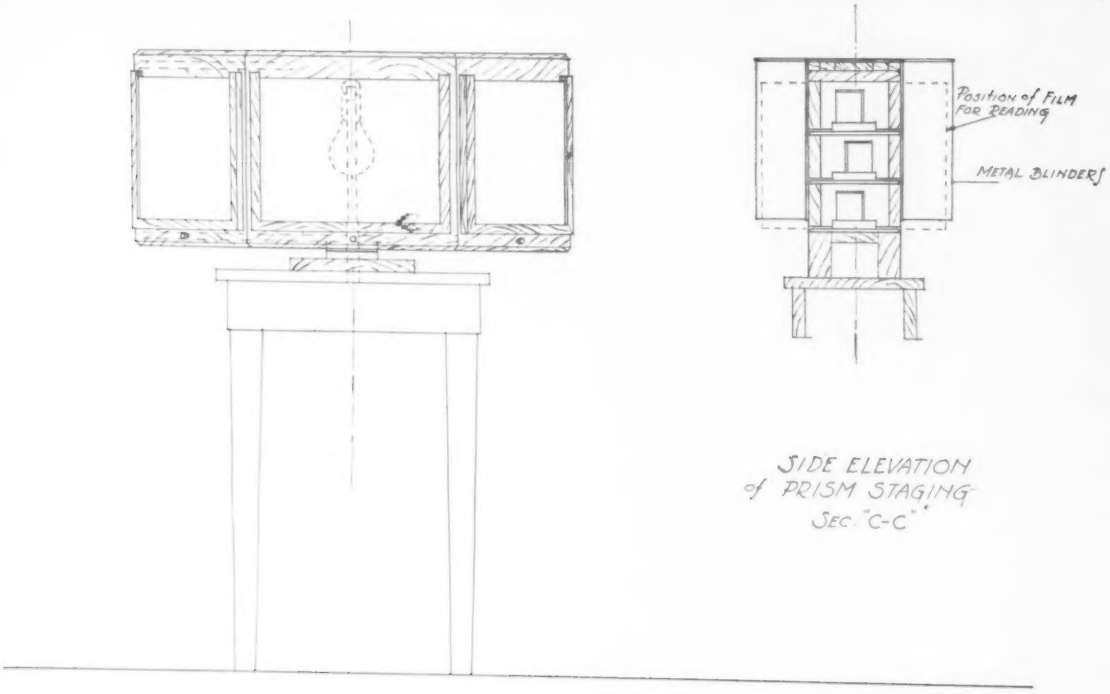
Position of Film for Reading
Metal Blinders
Side Elevation of Prism Staging Sec. "C-C"
End Elevation of Apparatus
Scale 2" = 1'-0"
Sheet (3)

Fig. 3

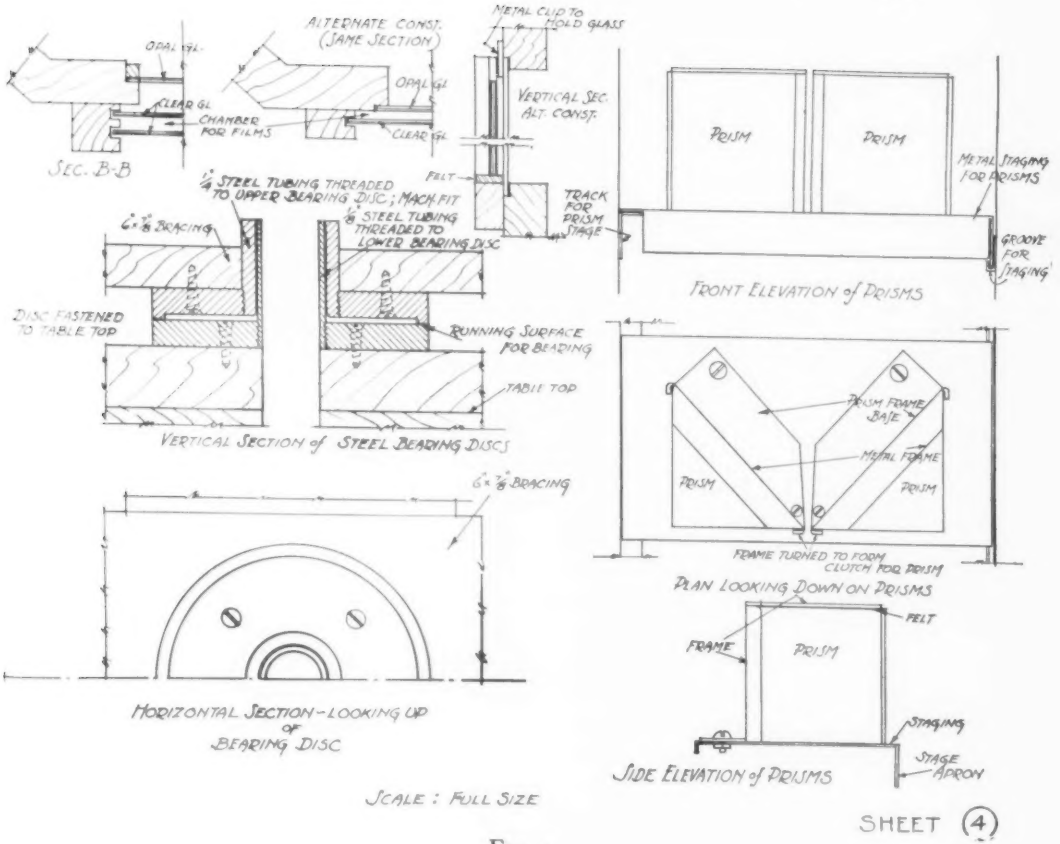
Opal Gl.
Clear Gl.
Chamber for Films
Sec. B-B
Alternate Const. (Same Section)
Opal Gl.
Clear Gl.
Metal Clip to Hold Glass
Vertical Sec. Alt. Const.
Felt
Track for Prism Stage
¼" Steel Tubing Threaded to Upper Bearing Disc; Mach. Fit
⅜" Steel Tubing Threaded to Lower Bearing Disc
6 - ⅞" Bracing
Disc Fastened to Table Top
Running Surface for Bearing
Table Top
Vertical Section of Steel Bearing Discs
6 - ⅞" Bracing
Horizontal Section - Looking Up of Bearing Disc
Prism
Prism
Metal Staging for Prisms
Groove for Staging
Front Elevation of Prisms
Prism Frame Base
Metal Frame
Prism
Prism
Frame Turned to Form Clutch for Prism
Plan Looking Down on Prisms
Felt
Frame
Prism
Staging
Stage Apron
Side Elevation of Prisms
Scale: Full Size
Sheet (4)

Fig. 4

FIG. 5

given patient is closely followed, it is not at all uncommon to have any given small area of a film "fall" in the same spot (area of vision) as in the preceding films. This permits of a comparison that one is not likely to make where it is necessary to take out the first pair of films in order to insert the second pair. This difficulty is more apparent when there may be four or six sets of films to examine. Facility and ease of revolving the boxes are essential for careful analysis of films. This feature, *i.e.*, almost instantaneous comparison of films, cannot be overestimated. It is often possible to see changes taking place in the shadows that would not be appreciated when comparing single flat films. In fact, we know how often the shadows in one of the stereoscopic films differ from those seen in the mate, due to the shift of the tube, and in consequence, a difference in relationship of shadows. It might also be mentioned that extrapulmonary shadows are often confusing in the single film whereas in the stereoscopic films they can be seen in their proper relationship.

The Trudeau stereoscope, the detailed drawings and photograph of which are here presented (Figs. 1, 2, 3, 4 and 5), has been in use at the Trudeau Sanatorium for the past twelve or fourteen years. Three observers can view the same set of films at one time. Each pair of prisms can be adjusted independently on a sliding stage.

The chambers for holding the films are transparent glass; in front, translucent, opalescent behind, insuring a reasonably flat surface to the films. The type of chamber also permits immediate easy change of the films. The tops of the boxes are open, thereby avoiding heating of the film windows.

"Blinders" are arranged so that when viewing the films, no other disturbing objects "strike" the eye. The side curtains also prevent counterreflection from other lights in the room. The inner surfaces of the side curtains are painted a dead black, as is most everything else lying in the path of vision. The value of these accessories is self-evident.

While the accompanying diagrams illustrate a flat bearing for the revolving boxes, a ballbearing arrangement is now being developed as an added improvement. In the present stereoscope, 500 watt Mazda bulbs, in a Mogul socket, are used; however, 200 watt bulbs with proper reflectors give about as much illumination to the pair of windows being used, here the rest of the windows would be shaded.

This particular stereoscope obviously is large, length and width over-all are 11 feet, 2 inches and 3 feet, 5 inches respectively. It would be feasible to utilize many of the details of this apparatus in the construction of one with four sides, which would be appreciably smaller.

The cost of building a stereoscope similar to the one herein described will depend upon many factors, *e.g.*, the wood used; whether four or six windows are desired; the quality of the diffusing opalescent glass; whether one, two or three sets of prisms are used; also the size of the prisms installed. Four-sided revolving boxes have many advantages, viz., the length over-all is considerably less, the boxes are not so heavy, the cabinet work is less complicated and easier to manipulate.

I wish to express my gratitude to the following assistants who contributed original ideas during the construction of this apparatus; Geo. Ulzheimer, Herman Autenreith, Christopher Von Wecheln, J. C. Hobbs, and also to J. L. Baker for his painstaking effort in preparing the detailed drawings.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers as space permits.

Allgemeine Grundlagen. Physik und Technik des Röntgenverfahrens. (Radiologische Praktika. Band XIV.) Von Dipl.-Ing. M. Brenzinger, A. Janitzky und Dr. E. Wilhelmy, Universitäts-Institut für Physikalische Grundlagen der Medizin zu Frankfurt a. M. Cloth. Price, 25.50 Rm. Pp. 237, with 275 illustrations. Leipzig: Georg Thieme, 1930.

This latest contribution on roentgen-ray technology comes from three investigators in Prof. Dessauer's Institute of Frankfurt, the enviable accomplishments of which, alone, speak well for a book of this nature. This work appears to be particularly adapted to the roentgenologist not having a thorough background in roentgen physics. The first of its three sections is devoted to the physics of roentgen rays, beginning with the fundamentals of electricity and magnetism, including electrical measurements, alternating current theory, transformer characteristics and electrical discharges in gases. The part on roentgen rays deals briefly with their properties, generation and measurement, with a limited discussion of the quantum theory of roentgen-ray production. The phases such as absorption and scattering, being of more direct medical application, are treated at greater length. A discussion of standard measurements of intensity and quality completes the chapter.

The second part provides an exceedingly complete discussion of roentgen-ray apparatus—both American and Foreign. It is opened with a discussion of methods and apparatus for measuring high voltages and currents, followed by a general treatment of rectification methods, including both mechanical and kenotron rectifiers, without making any attempt to compare their relative merits. The greater part of the chapter is devoted to a fairly complete description and discussion of most of the specific types of roentgen-ray generators. The array of present-day apparatus is impressive, to say the least.

The third part deals with roentgen-ray tubes and valve tubes. A general discussion is presented of the characteristics and properties of roentgen-ray tubes, including certain of their idiosyncrasies—the mastery of which should help to reduce our abuse of this exceedingly delicate gift of science. There is also an adequate description of the representative tubes of all makers, and a limited discussion of the proper application of each. The Lenard-Coolidge cathode-ray tube is described at the close and thus reflects that we may expect new developments in this direction.

At the close of each section is given a sufficiently complete list of reference books and original articles to guide the reader into the ways of as much knowledge as he cares to acquire.

Lauriston S. Taylor

La Roentgenthérapie; Ses Indications Cliniques. By Dr. Iser Solomon, radiologiste de l'Hôpital Saint-Antoine. Paper. Price, 20 fr. Pp. 208, with 14 illustrations. Paris: L'Expansion Scientifique Francaise, 1930.

This small monograph has been written for the general practitioner who wishes to acquaint himself with the present status of roentgen therapy, particularly its indications in the various diseases. The first part introduces the reader to the biophysical principles of roentgen therapy and contains chapters on the nature of roentgen rays, their physical, chemical, and biological properties, their production, the necessary apparatus and general treatment technique. In the second part, the clinical principles of roentgen rays in malignant diseases in general, in carcinoma of the uterus, of the breast, of the genitourinary organs in the male, of the gastrointestinal tract, of the blood and the circulatory system, of the nervous system, of the endocrine glands, of uterine fibroids, and hemorrhagic metropathy, tuberculosis, of the diseases of the skin, and miscellaneous diseases are related. The author expresses all doses in French roentgen units; it is stated that for practical purposes, 1 French R corresponds to 0.5 International r. A few illustrations show some of the latest apparatus and also one case of skin carcinoma before and after treatment.

This contribution of Solomon is well written. His conservative attitude and ripe experience

undoubtedly render the book valuable for the purpose designated by the author, but in addition, the specialist in roentgenology will also benefit by its study.

Ernst A. Pohle

The Origin of Lymphosarcomatosis and its Relation to other Forms of Leucosis in White Mice—Lymphomatosis Infiltrans Leucemica et Aleucemica. (*Acta radiol., Suppl. X*) By Carl Krebs, Hans Christian Rask-Nielsen and Aage Wagner. Paper. Price, Sw. cr. 8. Pp. 53, with 29 illustrations. Stockholm: P. A. Norstedt & Soner, 1930.

The authors studied the effect of transplantation of various types of lymphoid tumors on a very large series of white mice. It was found that the tumors grew more readily in mice which had received intensive roentgen irradiation all over the body with a dose which was just sublethal, than in non-irradiated animals. The tumors which developed were not always of exactly the same nature as those which were inoculated, the various types which grew being classified as leucosarcoma, lymphosarcoma, aleucemic lymphadenoma and leucemic lymphadenoma. These growths could be transplanted for several generations into irradiated mice. There was apparently no way of predicting what type of change would result. Leucemic changes in the organs were found in 0.29–0.58 per cent of 10,500 non-irradiated mice and in 3.6 per cent of 5,550 irradiated animals. However, successful inoculation of lymphosarcoma into irradiated mice markedly stimulated the development of leucemic changes (42 per cent of 850). The authors conclude that leucosis can occur as a reaction to nonspecific irritants. In this case roentgen rays decrease the resistance of the body to induced diseases, such as cancer or infection, by destroying a mechanism which under normal conditions regulates the growth of lymphatic tissue. The authors suggest the name of lymphomatosis infiltrans (leucemica et aleucemica) as a designation for a type of lymphoid tumor which grows under these conditions, and they point out certain similarities to leucosis in man. The gross and microscopic changes in the animals are shown in the 29 figures.

Raphael Isaacs

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

Vampré, E. Syndrome de Christian (polyurie, exophtalmie, syndrome adiposo-génital, déformation cranienne). (Christian's syndrome (polyuria, exophthalmos, adiposo-genital syndrome, cranial deformity).) *Rev. sud-am. de méd. et de chir.*, May, 1930, *1*, 459–464.

The author describes in detail a case of Christian's syndrome occurring in a boy fifteen years of age, who was examined for the first time on March 5, 1918, at the age of three. When eighteen months old the patient had an infection of the left ear and at the age of two he had whooping cough. In 1918, a roentgenogram of the skull revealed an external hydrocephalus with several areas of bony defect of both tables. A diagnosis of chloroma was made. At that time the patient also had a very marked polyuria (25 liters in 24 hours) and an exophthalmos which was so pronounced that on several occasions a subluxation of the eyeballs occurred.

The patient was seen for the second time on Feb. 6, 1929, when the polyuria and the marked exophthalmos persisted. The head was very voluminous and there was obesity with rudimentary appearance of the genital organs. At this time a diagnosis of infundibulo-hypophyseal lesion was made, and deep roentgen therapy administered. On Jan. 23, 1930, the treatment was repeated (technique of irradiation is not indicated). A marked amelioration followed. The polyuria was reduced to 5–6 liters per day, the headaches disappeared and there was slight improvement in the somatic development (patient reaching the height of 1 meter 47 cm.), but the exophthalmos and the marked thirst persisted.

Roentgenograms of the skull taken Jan. 24, 1930, showed an irregular quadrangular appearance of the sella turcica, with sinking in and erosion of the base. The anterior fossae of the cranium revealed limited development as compared to the posterior fossae. At the level of the fronto-parietal and occipito-parietal sutures there was evidence of osteitis. The sphenoidal sinus was opaque but the other accessory sinuses appeared transparent. Thus the appearance, as a whole, was that of a lesion of the sella turcica.

In reviewing the entire history and course of the case, recently a diagnosis of Christian's syndrome was made. The original diagnosis of chloroma was discarded on account of the long duration of the disease and since the lesion failed to develop into leucemia. The polyuria, exophthalmos, adiposo-genital syndrome and cranial deformities are typical of Christian's syndrome. The roentgen appearance of the infundibulo-hypophyseal region, as well as the fact that the administration of deep roentgen therapy over this region resulted in a very marked amelioration of the condition as a whole suggests that Christian's syndrome, as already suggested by Christian himself, must be the result of some pituitary disturbance. Lisser thought that infection might be the provoking cause. This theory seems to have some support in the author's case through the fact that the infection of the left ear and the whooping cough preceded the onset of the Christian's syndrome.—*T. Leucutia.*

Moniz, Egas. Die arterielle Encephalographie als Methode zur Lokalisierung von Hirntumoren. (Arterial encephalography as a method for the localization of brain tumors.) *Klin. Wchnschr.*, June 11, 1929, *8*, 1118–1121.

The author describes in detail his procedure of arterial encephalography (see this Journal, July, 1929, *22*, 79) and discusses its value in special types of brain tumors. One case in which not only an accurate localization but also a precise estimation of the size of the tumor was possible is described in detail and the roentgenograms are reproduced. The following signs were found to be of special value: the displacement of certain arterial groups as for example the Sylvian group (the author designates under this name the arteria cerebri media which in the projection of the arteriograms is invariably accompanied by two other arteries, the temporalis posterior and parietalis posterior), the lack of visualization of part of the arterial system in the neighborhood of the tumor or the appearance of new vessels (as compared to the normal side) due to vascularization of the tumor, and

finally a possible visualization of the tumor itself

The method was used in 40 cases without serious accidents. In 9 cases, 6 of which were operated upon, a correct diagnosis could be made. Of the 6 operated cases 4 terminated in complete healing and 2 died.—*T. Leucutia.*

Gutzmann, Hermann. Röntgenaufnahmen von Zunge und Gaumensegel bei Vokalen und Dauerkonsonanten. (Roentgenography of the tongue and soft palate during the pronunciation of vowels and consonants.) *Fortschr. a. d. Geb. d. Röntgenstrahlen*, March, *1930*, *41*, 392–404.

The author analyzed the position of the tongue and soft palate during the pronunciation of all vowels (for c and c′ scales) and a certain number of consonants (m, n, ng, f, w, ss, s, ch, sch, j, l, r).

For the visualization of the tongue, goldbeater's skin coated with a very thin layer of iodipin and barium (later, because of the rather unpleasant taste of iodipin, with barium sulphate alone) was placed on the surface of the tongue. For the visualization of the soft palate the same procedure was applied except that here because of its better adherence peach skin was used instead of goldbeater's skin. For the roentgenography of the consonants m, n, and ng, the nose, lip and chin were also marked with a very thin coating of barium paste, while for the study of the hyoid bone and larynx, 0.30 per cent iodipin was sprayed into the larnyx. The consonants b, d, z, p, t, k, were not analyzed since for them cinematography would be the only worthwhile method.

The study is only in its beginning stage but it has already been found that the position of the tongue and soft palate in many instances varied from the generally accepted standards of phonetics.

In a further note the author mentions that after the completion of his work he was visited by Professor O. Russell of Columbus, Ohio, who showed him several roentgenograms which he had made by the same method (goldbeater's skin and iodipin), although the roentgenograms are not so sharp, some of them even necessitating a retouching. Russell's series includes over 400 children.—*T. Leucutia.*

NECK AND CHEST

Raffo, Ernesto. Le diagnostic des corps étrangers des bronches. (Diagnosis of foreign bodies of the bronchi.) *Rev. sud-am. de méd. et de chir.*, May, 1930, *1*, 477–484.

The author describes briefly 4 unusual cases of nonopaque foreign bodies within the bronchi in which diagnosis was made with the aid of roentgen examination. In discussing the roentgen procedure in foreign bodies of the bronchi the author advises the following rules: In case of metallic or opaque foreign bodies, films must be taken in the anteroposterior and lateral views. In a few instances the intrabronchial injection of lipiodol or the insufflation of bismuth subcarbonate will help in differentiating suspicious shadows, especially from calcified lymph nodes. The exact localization of the foreign body for the purpose of extraction is accomplished best by the roentgenoscopic examination in two planes.

In case of nonopaque foreign bodies, two films are taken, one at the end of inspiration and one at the end of expiration. If the foreign body entirely obstructs the lumen of the bronchus, an obscuration of the lobe affected (obstructive atelectasis) is observed during inspiration as well as during expiration. The heart and aorta are displaced towards the diseased side, and there is elevation of the diaphragm. If the foreign body has produced a distention or emphysema of a segment of the obstructed lobe, the films will reveal an increased transparency of the lung affected, with deviation of the mediastinum towards the opposite side and with a depression of the diaphragm and limitation of its movement.

In doubtful cases of foreign bodies a negative roentgen finding should not be considered as conclusive.

Differential diagnosis includes pneumonia, bronchopneumonia, laryngeal diphtheria (in case of subglottic edema), the chronic forms of purulent pleuritis and pulmonary tuberculosis.—*T. Leucutia.*

Heiman, Henry, and Cohen, Philip. Peribronchial infiltration in children. *M. Clin. N. Am.*, Sept., 1930, *14*, 411–424.

The authors present an atypical but frequent pulmonary complication which they have observed to follow influenza and measles and occasionally pertussis, scarlatina and upper respiratory infections. It is to be differentiated from lobular, broncho- and interstitial pneumonia whose characteristic pathological processes are an involvement of the alveoli with

or without consolidation, and discrete or confluent areas of inflammation.

The physical findings in this atypical pulmonary disease are broad areas of dullness on percussion, most often bilateral, with no rales and very slight changes in breath sounds. This is in contradistinction to the usual physical signs of pneumonia. The temperature ranges around 100° to 101° F. in the evening, the child is not particularly ill though it complains of cough and malaise. The blood counts are not characteristic. The prognosis is excellent though recurrences are common but milder.

As the physical signs point to an extra-alveolar or interstitial process of a low grade, subacute type, different from the usually accepted picture of interstitial pneumonia, the authors have advanced the term "peribronchial infiltration." They have found at times that the above process may be the first step to a bronchoalveolar or bronchopneumonia.

Roentgen examination reveals fine lesions following the lines of the blood vessels and lymphatics with increase of the lung markings. Following recovery there remained only an accentuation of the lung markings on the roentgenogram.

Differential diagnosis involves typhoid, tuberculosis, pyelitis, bacteremia and uncomplicated influenza. Treatment is symptomatic and in some cases roentgen therapy which is therapeutic both for the lymphocytic infiltration and for the fibrous replacement of the interstitial tissue.

There were no deaths and as a result no autopsies to demonstrate pathology.—*Fay K. Alexander.*

LEUNDA, JUAN JOSÉ, and CARRAU, ANTONIO. Dilatation bronchique chez l'enfant donnant une image de pleurésie mediastine. (Bronchial dilatation in the infant giving a picture of mediastinal pleurisy.) *Bull. et mém. Soc. méd. d. hop. de Paris*, 1930, *54*, 58–65.

Leunda and Carrau report 4 cases, the patients ranging from five to eleven years, in each of which roentgenograms of the chest showed a shadow occupying the lower inner portion of the right chest, running downward and outward from the right hilum shadow. This appearance they considered typical of a mediastinal pleurisy, but after the injection of lipiodol, dilatation of the bronchus alone, or associated with chronic parenchymatous lesions, some with or without lesions of adhesive pleurisy, was found.

The clinical diagnosis of dilatation of the bronchus or bronchiectasis in the adult is not easy, but is even more difficult in infants or children because in the latter a clinical sign of great value, expectoration, is often lacking. The authors think that occasionally in certain types of cases, a diagnosis of bronchiectasis can be made from the roentgenogram without the injection of lipiodol, but very often the shadows are not sufficiently clear to make such a diagnosis possible, without the aid of the injection of the opaque medium. If the diagnosis of mediastinal pleurisy, when the symptoms of compression as described by Dieulafoy are lacking, is based solely on the finding of the classical cardiodiaphragmatic shadow, it often proves to be inaccurate. This shadow can correspond, as in the authors' cases, to that of bronchial dilatation, and the paravertebral angle shadow does not always represent the associated lesions of pleuropulmonary sclerosis or peribronchitis in the base of the lung.

Rist, Jacob and Trocne explain the lesions of peribronchitis, chronic pneumonia and generalized adhesive mediastinal pleurisy as a phenomenon superimposed upon chronic bronchial dilatation. The close relation of the bronchi with the mediastinal pleura explains these reactions.—*R. S. Bromer.*

VISCHIA, QUINTINO. Probabile empiema mediastinico posteriore perforato in un bronco. (Probable posterior mediastinal empyema perforated into a bronchus.) *Arch. di radiol.*, May-June, 1930, *6*, 485–502.

A patient twenty years of age had had a bronchopneumonia at the age of fourteen, and ever since that time had expectorated fetid pus. She had a slight intermittent fever but no pain. The clinical signs were those of abscess of the lung but a diagnosis of posterior mediastinal empyema perforated into the left bronchus was made from the roentgenogram which in the left anterior oblique position showed a triangular shadow communicating with a saccular dilatation of the bronchus. The surprising feature of the case was the patient's good condition though the disease had persisted for six years. The prognosis is bad because the chances for successful surgical operation are poor on account of the adhesions between the pleura and lung. —*Audrey G. Morgan.*

Keller, William L., and Callender, George R. Neurofibroma arising on the pericardial pleura. *Ann. Surg.*, Oct., 1930, *92*, 666–672.

Single neurofibromas of the viscera are relatively rare. These tumors are derived from the connective tissue structures of the nerve. The author reports a case in a Filipino woman, aged thirty-eight, in which the tumor was successfully removed. The roentgenogram shows a rounded shadow at the left base which moved with diaphragmatic excursion. The patient had pulmonary osteoarthropathy presumably secondary to the changes produced as a result of the location of the tumor. The patient complained of pain in the joints which disappeared after operation. A roentgen examination 1½ years after removal of the tumor shows no evidence of recurrence.—*E. P. Pendergrass.*

Craver, Lloyd F. Diagnosis and treatment of thymoma. *M. Clin. N. Am.*, Sept., 1930, *14*, 507–525.

The diagnosis of thymoma is best made by the usual methods of correlating symptomatology and physical examination, followed by roentgen examination of the chest, revealing the widened mediastinal shadow.

The most common findings on examination are those due to pressure on blood vessels, nerves, trachea and esophagus with resulting congestion and swelling of the face and upper extremities, pain over distribution of nerve roots, dyspnea and dysphagia. Additional signs and symptoms not quite so commonly found are exopthalmos, tachycardia, supraclavicular and axillary nodes.

Thymoma tends to metastasize extensively and may involve any region of the body. Pulmonary metastases develop as discrete, well-circumscribed, round or oval dense shadows which may or may not produce symptoms. The bone metastases have appeared in many bizarre forms, though areas of increased density 2–3 mm. in diameter over which terrific pain is elicited on slight pressure are rather characteristic. Intracranial metastases have been reported.

Occasionally the differential diagnosis from aneurysm may be difficult and in such instances the application of a therapeutic dose of radiation will help. Such a test will not harm the aneurysm, and, since most thymomas are very radiosensitive, inside of a month the diagnosis will usually be made. The author does not believe a biopsy for diagnosis is essential in this group of diseases.

Most cases of thymoma will require repeated irradiation and in order to conserve the skin only high voltage penetration type should be used, or the radium element or emanation pack, at a distance. If following the first treatment the tumor disappears the patient should not be allowed to remain away for long periods, even if there is no evidence of disease. A tumor which responds so readily to treatment will recur readily and metastasize under strange guises and one should be alert for all possible recurrences and metastases.

A case report is given illustrating the above points.—*Fay K. Alexander.*

Chizzola, G. Di una nuova tecnica per lo studio radiologico delle affezioni stenosanti dell'esofago. (A new technique for the roentgen study of stenosis of the esophagus.) *Radiol. med.*, Apr., 1930, *17*, 403–409.

The usual technique for roentgen examination of the esophagus does not permit of profound study of stenosis. The modifications proposed heretofore have not been entirely satisfactory. Chizzola has devised a new method which he has been practising for some time with very good results; by means of it he can determine the exact extent and condition of the stenosis and the condition of the part of the esophagus below the stenosis.

He first makes an examination by the usual technique to determine the site and degree of the lesion. Then he gives the patient a drink of Rivière's solution in order to produce gas in the stomach. He then swallows an opaque viscous material thick enough to outline the stenotic part of the esophagus. Then he swallows an opaque paste, which gives a durable imprint of the upper end of the stenosis. The gas escaping from the stomach then distends and clears up the part of the esophagus below the stenosis. The roentgen picture obtained is very clear and instructive. It shows the organ above the stenosis (positive picture) and the part below it (negative picture); it also shows the exact extent of the stenosis. Roentgenograms are given illustrating the findings.—*Audrey G. Morgan.*

ABDOMEN

Anzilotti, A. Sulla diagnosi di natura nelle neoplasie dello stomaco. (Diagnosis of the

nature of tumors of the stomach.) *Radiol. med.*, Apr., 1930, *17*, 455–480.

The author describes 3 cases of benign tumor of the stomach: a myoma of the antrum of the pylorus, a circular myoma of the pylorus (verified by surgical operation) and a polyp which at times became invaginated into the duodenum (this latter fact was not verified by the surgeon). Benign tumors of the stomach are rare and often it is impossible to make a differential roentgen diagnosis of their nature, particularly the forms with stenosis and dilatation of the stomach, such as myoma of the pylorus. The roentgen picture varies depending on whether the tumor is inside or outside the stomach. A careful study of the form and size of the stomach, peristalsis, the mucous folds, the profile of the two curvatures and the emptying time are very important. The lacunar zone is quite characteristic and different from that of malignant tumor. In malignant tumor it is irregular and gives a jagged appearance to the stomach shadow while the defect in benign tumor is rounded and distinctly circumscribed; it is central in site and insular in appearance being surrounded on all sides by barium. This insular appearance is never seen in cancer. The rounded or oval outline distinctly circumscribed is due to the fact that there is no infiltration of the stomach wall by the tumor. The most characteristic insular appearance is in pedunculated tumors. The differential characteristics of the benign lacuna have to be looked for carefully in order to be seen.—*Audrey G. Morgan.*

EVANS, JAMES A. Duodenal stasis. *Radiology*, 1929, *13*, 222–228.

Great conservatism is urged in advising surgery for incidental findings of duodenal stasis. Evans recommends that the roentgenologist study carefully the passage of barium into the jejunum and be guided by the presence of an accompanying gastric stasis. Fluoroscopic study gives a better idea of duodenal function and stasis than the surgeon can obtain at operation, especially in the case of mesenteric pedicle or middle colic artery compression. Special stress is laid on duodenal stasis in the pars horizontalis inferior and the accompaning antiperistalsis in the pars descendens as a reflex phenomenon due to gall-bladder disease, duodenal ulcer, and possibly an irritable appendix or an irritable colon. The roentgenologic differentiation between compression by the middle colic artery and compression by the superior mesenteric artery is difficult, though the point of obstruction being present at the lowest portions of the pars descendens and associated with a mobile cecum strongly suggests the former. The diagnosis of the cause of stasis in the pars horizontalis superior and pars ascendens is not subject to so great an error.—*J. D. Camp.*

GAVAZZENI, ANTONIO. Il sussidio dell'indagine radiologica nello studio delle coliti croniche. (Roentgen examination in chronic colitis.) *Radiol. med.*, Apr., 1930, *17*, 433–455.

From a careful roentgen study of about 30 cases of chronic colitis the author concludes that it is of value not only in excluding other diseases, such as specific diseases and tumors but also directly in localizing and showing the form of the chronic colitis. There is no true pathognomonic picture of chronic colitis but a complex of roentgen symptoms that differ from normal, a careful study of which is useful in diagnosis. The symptoms involve both the motility and form of the colon. Generally there is hypermotility, which leads to more rapid passage of the opaque medium through the colon, particularly the first part of it; this hypermotility is frequently accompanied by stasis in the ileum. Normally all the barium passes the ileocolic sphincter into the colon between the sixth and ninth hours, so at the end of the ninth hour there is none at all in the ileum. When none of the barium has passed the ileocecal sphincter at the sixth hour and at the end of the ninth hour there is still barium in the terminal part of the ileum there is stasis of the ileum, probably due to spastic contracture of the sphincter as a defense reaction to protect the irritated colon. Following the hypermotility at first there is a slowing of motor function, shown in examinations between the twenty-fourth and forty-eighth hours.

The most important morphological changes are in the haustra. They are very irregular in shape and size and distance from each other. Sometimes they extend so deep as to interrupt the column of barium entirely, giving the picture called the rosary colon. These changes in the haustra indicate spasm of the colon. The distal segment of the colon is the part that undergoes spastic contraction most easily. Of course there is often spastic contraction of the sphincters of the colon. Sometimes the haustra disappear so completely as to give the in-

testine the appearance of a smooth tube; sometimes the picture is that of a torn ribbon and sometimes a dotted strip. More frequently the barium does not pass entirely through a segment of the intestine but leaves a thin stripe which Crane calls the string sign. He thinks this sign is found in almost all cases of mucomembranous colitis and it shows particularly on the morning of the second day after the barium is taken. These latter pictures are indications of spastic zones alternating with atonic ones. The variety in roentgen pictures is as great as that in clinical symptoms.

As to whether the different forms of colitis can be differentiated by roentgen examination, this cannot be done definitely either but there are certain signs that predominate in the different clinical forms. In mucous colitis the roentgen findings are not very marked. Generally there is some disturbance of motility of the colon and more or less spasm; sometimes there are peristaltic or antiperistaltic movements or movements en masse. In mucomembranous colitis the signs are more marked, particularly if the examination is made during an attack. There are long tracts of the colon which show the string sign or the torn ribbon picture; the marked retardation in emptying time is due to the habitual constipation which is seen in this disease. In ulcerous colitis the barium passes rapidly through the diseased part of the intestine so that emptying time is greatly decreased. The most frequent signs are spasticity of the affected zone, irregularity of the outlines and particularly marbling, due to the deposition of barium between the ulcers or an irregular mixture of the contrast salt with gas.

In conditions of irritability of the colon in which the disturbance is chiefly functional the roentgen picture often gives distinct pictures of deranged function of the colon while the clinical symptoms are still slight.—*Audrey G. Morgan.*

Rankin, Fred W., and Brown, Philip W. Diverticulitis of the colon. *Surg., Gynec. & Obst.*, May, 1930, *50*, 836–847.

From their study the authors conclude that the incidence of diverticulosis is about 5 per cent of persons who have symptoms referable to the large bowel, but probably actually occurring in about 1 per cent of all persons. Diverticulitis probably occurs in about 17 per cent of cases of diverticulosis and in most instances is chronic in its cause and subject to exacerbations.

Etiologically there is probably no one factor responsible for the production of diverticula. Among the more important factors are inherent muscular weakness in the wall of the bowel and environmental conditions, obesity, and constipation. Diverticulitis, itself, is the result of improper emptying of the involved diverticulum with subsequent inflammatory reaction incident to such stasis. There is probably no basis for the belief that diverticulitis predisposes to carcinoma.

Diverticula occur most commonly in the sigmoid, but they may be distributed throughout the colon, usually with decreasing frequency from the left to the right side of the bowel. In the series studied, 60 to 70 per cent occurred in males. Diverticulitis occurs almost entirely in persons of middle age who are inclined to be corpulent and who lead sedentary lives.

In the symptomatology, pain in the lower left portion of the abdomen is the outstanding symptom. With this, there is usually an associated constipation, while at times there is diarrhea. Bleeding is not a common symptom; when it occurs, malignancy should be suspected but will not often be found. A palpable tumor due to the inflammatory reaction is a common finding.

The roentgen examination holds first place among diagnostic procedures in the establishment of the diagnosis of diverticulosis. The characteristic roentgen appearance is the rounded, knob-like projections from the lumen of the colon. These show considerable variation in size.

The roentgen signs of diverticulitis are spasm and hypermotility. All degrees of spasm are seen, from the mild type, manifested by a sharp serrated appearance of the haustra in a somewhat narrowed segment of bowel, to almost complete occlusion of the lumen. The condition is likely to be confused with carcinoma but the differentiation can usually be accomplished by careful and painstaking observation.

The treatment of diverticulitis is preferably medical and usually only when complications occur is operation to be undertaken. The most common complications are abscess, fistula, and perforation.—*Karl Kornblum.*

Vallebona, A. Sulle formazioni opache che si riscontrano nell'addome con particolare ri-

guardo alle cisti dermoidi ed alle calcificazioni della milza. (Opaque structures in the abdomen, particularly dermoid cysts and calcifications of the spleen.) *Radiol. med.*, Apr., 1930, *17*, 365–396.

The author divides calcareous structures in the abdomen into ones in cavities, such as the bladder and gall-bladder, ones in the parenchyma of organs, such as the liver and spleen and ones in tumors and parasitic calcifications. Some shadows are characteristic, such as the coral-like shadows of calcifications in the kidney pelvis, but others are very hard to diagnose.

Phleboliths are generally in the pelvis and are characteristic in site and form. They are generally between the spine of the ischium and the horizontal ramus of the pubis, are almost always round or oval, and generally multiple and bilateral. In such cases it is easy to make the diagnosis but in some cases they follow the course of the ureter. An illustrative case is described in which phleboliths were at first taken for stones in the ureter, but examination with an opaque sound showed that they lay outside the ureter.

Calcifications of lymphatic glands show a much more varied localization. The glands anywhere in the body may become calcified after inflammation, particularly after tuberculosis. And there is nothing characteristic in the shape of the shadows. A number of cases are described in which roentgen signs of tuberculosis were accompanied by shadows of calcified lymph glands in various parts of the abdomen. Sometimes these calcified glands are accompanied by calculi of the urinary tract and then differentiation is still more difficult. A number of cases are cited from the literature.

Another case is described which illustrates a still more puzzling localization of abdominal calcifications. The patient was a woman of thirty-five who some years before had had peritonitis. She was sent for roentgen examination on account of an accident with possible lesions of the pelvis. The examination showed an irregular opacity in the shadow of the sacrum to the left of the midline and another on the right. They suggested calcified fibromyoma but seemed to be too far posterior for that. There were no clinical symptoms to indicate calculosis of the urinary tract. The most probable hypothesis was that they were caused by calcification of plastic structures in the peritoneum. Lejeune in 1911 called attention to the fact that there may be true calculi in the peritoneum. Those in the author's case were not free, but fixed calculi of the peritoneum are more frequent than movable ones.

The most definite roentgen sign in the diagnosis of dermoid cysts of the ovary is the demonstration of teeth. The cysts also sometimes contain bone but even this sometimes escapes detection as in one of the two cases described by the author. Sometimes the walls of the cysts are visible, even though not calcified. This is probably due to the greater transparency of the fluid in the cyst and the tissues around the capsule. The walls of the cyst were not visible in either of the author's two cases.

Tuberculous areas in the spleen may become calcified and calcium may also be deposited in old abscesses and infarcts. Small thrombi may also become calcified. Calcium may be deposited in the capsule of the spleen if it has undergone certain pathological changes. And parasites of the spleen, echinococci being the most frequent, may become calcified. Two typical cases of calcifications in the spleen are described.—*Audrey G. Morgan.*

GENITOURINARY SYSTEM

TURANO, LUIGI. Immagini pielografiche con l'iniezione intravenosa di uroselectan. (Pyelography by means of intravenous injection of uroselectan.) *Arch. di radiol.*, May–June, 1930, *6*, 503–522.

Uroselectan is a pyridine derivative and contains 42 per cent of iodine combined organically. It is given intravenously for taking pyelographic pictures. The pictures are less intense than ones taken by the retrograde route but are distinct enough to be of great value in diagnosis. In some cases the author has found the pictures indistinct after 10, 15 or 20 minutes but very distinct after half an hour. In pathological cases elimination is more retarded than in normal ones but the pictures are much more distinct. To get good pyelograms the technique must be perfect and the author prefers rather soft rays and a short exposure.

Ten cases of various kidney lesions are described in which uroselectan was used and the roentgenograms are given. The great advantage of this method over the retrograde one is that the function and morphology of the kidney pelvis can be studied at the same time and the pictures are more accurate as the pelves are not distended with fluid. Retrograde examina-

tion is still necessary in some cases to study some of the finer details that are not shown by the intravenous method. The intravenous method is absolutely harmless while there is some danger in the introduction of gas into the kidney. When any disturbances are caused by the intravenous injection, such as chills, temperature and more rarely vomiting, or a slight urticarial eruption which the author has seen in two cases, they only last a little while and are not serious.—*Audrey G. Morgan.*

von Lichtenberg, A. Kidney and ureteral lesions secondary to adnexal disease. *J. Urol.*, July, 1930, *24*, 1–29.

The author states that a large number of kidney region symptoms in males have their origin in adnexal disease and that a number of cases of ureteral strictures, kinks, periureteritis, perinephritis and pyogenic kidney have such an origin.

He makes a plea for a viewpoint of "system pathology" rather than "organ pathology" as the way to a correct diagnosis and a background for proper treatment.

The article is profusely illustrated with pyelograms.—*P. A. Bishop.*

Fraticelli, A. Un caso di rene ectopico calcoloso. (A case of calculus in an ectopic kidney.) *Radiol. med.*, March, 1930, *17*, 325–326.

About three years ago the patient for the first time had a colic that was diagnosed as kidney colic. It was brief and not very intense and was not followed by hematuria or fever. A few days before he came to the author for examination he had another more intense colic with extreme pain radiating to the left thigh. There was blood in the urine and the patient had fever for a few days. Cystoscopic and chromocystoscopic examination by a urologist showed that the function of the right and left kidneys was complete. Roentgen examination showed a pale shadow at the left wing of the sacrum. A first roentgenogram with a plate 24 x 30 did not show the shadow of the left kidney but a second one with a larger film showed the left kidney at the level of the sacroiliac joint with a shadow in it probably caused by calculus. A roentgenogram is given showing the position of the kidney and the stone. The patient refused operation but the roentgen picture is conclusive.—*Audrey G. Morgan.*

Campbell, Meredith F. Submucous fibrosis of the bladder outlet in infancy and childhood. *J. Am. M. Ass.*, May 3, 1930, *94*, 1373–1378.

Seven cases of submucous fibrosis of the vesical outlet occurring in infancy and childhood are reported. The condition appears to be confined to the male sex, probably due to some anatomic relationship of the prostate to the vesical outlet. Although the author has found but 12 cases of this lesion in children reported in the literature, he believes it to be far more common than is generally appreciated. A more thorough urologic study in children would reveal this lesion responsible for many cases of chronic pyuria, enuresis, urinary difficulty and chronic urinary retention. The age at which the symptoms are first manifested varies greatly and depends on the relative degree of urinary obstruction. Symptoms may be present from birth.

The etiology is unknown. In all reported cases in childhood the disease was congenital. A similar lesion occurs in males rather commonly as the result of urogenital infection. In many of these cases the history would suggest the condition to have been congenital.

Histologically there is a great increase in connective tissue in the submucosa of the vesical outlet. This may extend into the trigonal musculature and adjacent bladder wall. The entire circumference or only a portion of the outlet may be involved. In the latter instance the lower segment is most often the site. This produces a form of median bar obstruction. As the condition progresses the vesical orifice becomes elevated, abnormally small and tight. The results of these changes are the same as those produced by other types of intravesical obstruction, namely, vesical hypertrophy, bladder diverticula and stone formation, dilatation of the ureters and renal pelves leading to complete destruction of the kidneys.

In the symptomatology, frequency and difficulty in urination are constantly observed. Terminal dribbling may result from inability to properly close the bladder. Chronic bladder overdistention leading to incontinence may give rise to the diagnosis of enuresis. Vesical distention causes lower abdominal pain while dilatation of the pelves gives rise to renal pain. With the occurrence of infection, pyuria and fever become manifest. These symptoms often lead to the erroneous diagnosis of pyelitis or

cystitis. With marked renal damage, manifestations of uremia appear. These may be in the form of gastrointestinal or neurological symptoms which in themselves often result in errors of diagnosis. As a terminal event coma results and with it diagnosis of chronic interstitial nephritis is made. Because of lowered general resistance intercurrent infections are often terminal.

The diagnosis is not difficult and is conclusively made by cystoscopy. In establishing the diagnosis certain data should be obtained such as the estimation of the nitrogenous blood retention, two hour phenolsulphonphthalein elimination, plain roentgenograms of urinary tract for the presence of calculi and for the detection of spinal abnormalities, notably spina bifida. The latter is important because the neuromuscular vesical disturbances associated with spina bifida are difficult to differentiate from vesical neck fibrosis. Cystograms are important in the detection of bladder dilatation, trabeculation, diverticulosis or abnormal contour; often the entire urinary tract will be shown. Difficulty in catheterization at the bladder neck is an important clue to the probable diagnosis. A large bladder residuum is usually present. The true diagnosis is made by cystoscopy as this permits direct inspection of the area of fibrosis, the complicating conditions in the bladder and ureteral orifices. The bladder neck will firmly grasp the infant cystoscope and as the instrument is withdrawn from the scar, a "jump" may be felt.

In the differential diagnosis congenital valves of the posterior urethra, ureteral stricture and most especially neuromuscular vesical disease must be considered.

The prognosis is in direct ratio to the degree of renal injury.

The treatment is surgical excision, using the same preoperative and postoperative measures as are employed in prostatectomy. In the presence of a large residuum, slow decompression is highly essential. Suprapubic drainage is preferable to an indwelling catheter for this purpose inasmuch as children invariably fill the catheter out. A forced fluid intake is imperative. For the excision of the sclerotic tissue the miniature punch instrument of Young may be used and is preferable to the perineal attack or of a suprapubic cystotomy. In certain cases the latter procedure is advisable as it permits of treatment of complicating conditions in the bladder such as diverticula.

In a few of the cases reported in the literature, removal of the fibrosis was accomplished with eminent success. To prevent the nephropathies occasionally seen in adults as the result of this lesion the importance of the early recognition and proper treatment of this condition in childhood is emphasized. It is urged that a more general use of the modern urologic methods of diagnosis and treatment be made in children.—*Karl Kornblum.*

NERVOUS SYSTEM

CASE, JAMES T. Three cases of neuroma. *Am. J. Surg.*, March, 1930, *8*, 648–653.

The author presents 3 cases of tumor of the peripheral nerves, all of which had positive roentgen findings previous to operation.

The first was an extensive neurofibroma of the head and face in which the roentgen study revealed thinning of the cranial bones and distortion of the upper and lower jaw. This patient was operated on and as much of the tumor was removed as possible. Following this he was given roentgen irradiation and to date has no recurrence, a period of about fifteen years. The patient had had previous surgical removal, though with no benefit as the tumor continued to grow. This suggests that it may be worth while to supplement surgery with either roentgen rays or radium according to the case.

The second case was studied for the relief of indigestion and epigastric pain. An intravenous cholecystogram revealed multiple nonopaque gallstones and a gastrointestinal roentgen study showed a small filling defect on the greater curvature near the pylorus which was thought to be due to the presence of the rather large gall-bladder. At operation a small tumor mass was found on the posterior wall near the pylorus which was removed. The pathological report was neurofibroma. Statistics in one group of cases revealed approximately one benign tumor of the stomach to about 80 malignant growths.

The third case was a neurofibroma of the posterior tibial nerve which on roentgen study revealed the presence of a soft tissue tumor between the Achilles tendon and the bones of the leg, causing marked displacement of the calcareous posterior tibial artery.—*Fay K. Alexander.*